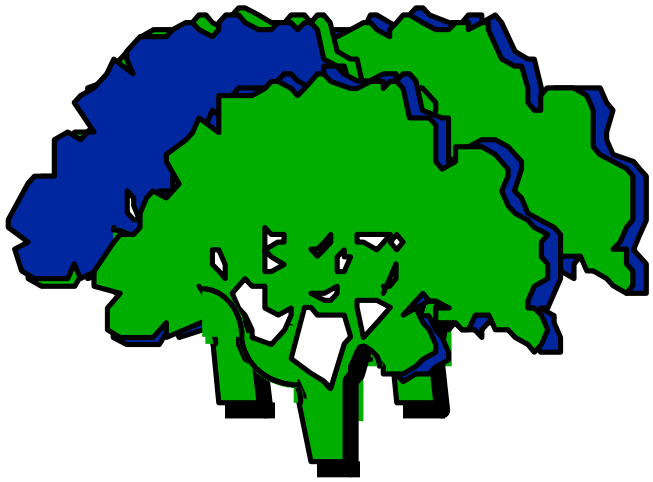
VERSION 1.0

ENVIRONMENTAL RESTORATION REQUIREMENTS DEFINITION



Volume IC: Decommissioning

May 30, 1997

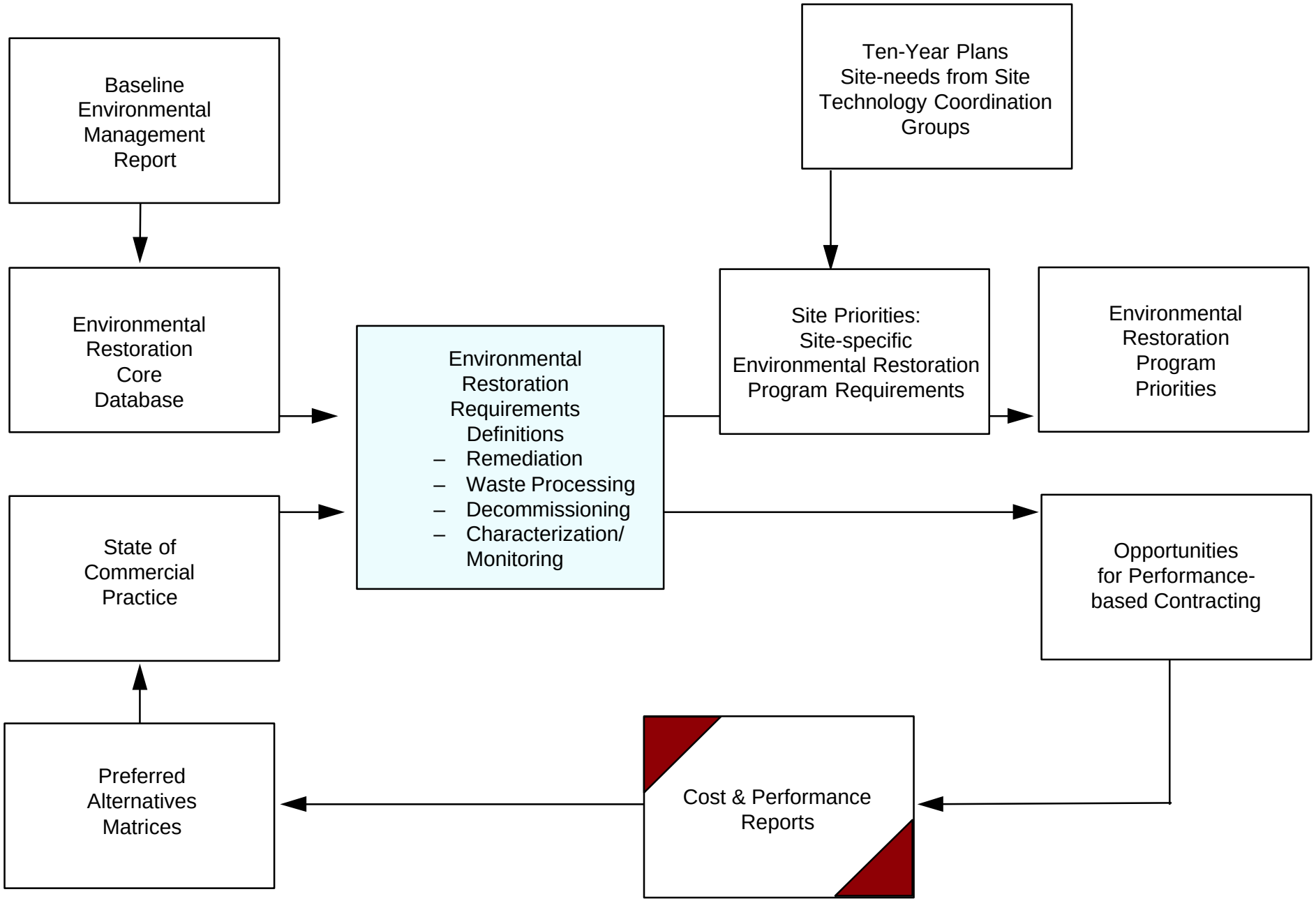
THE SHORT ANSWER

INTRODUCTION

PROBLEM SET DEFINITION

TECHNOLOGY SCREENING ANALYSIS

NEXT STEPS


Baseline Environmental Management Report
Ten-Year Plans Site-needs from Site Technology Coordination Groups
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Environmental Restoration Requirements Definitions
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– Waste Processing
– Decommissioning
– Characterization/ Monitoring
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Environmental Restoration Program Priorities
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Preferred Alternatives Matrices
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UNDERSTANDING ENVIRONMENTAL RESTORATION REQUIREMENTS IS CRITICAL TO ADDRESSING PROGRAM PRIORITIES AND TECHNOLOGY NEEDS

- The Environmental Restoration Requirements Definition answers the following questions:
  - What problem sets comprise the Environmental Restoration program?
  - What problem sets are readily satisfied by commercial practice?[1]
  - What problem sets are not fully addressed by commercial practice?
  - Where are the opportunities for performance-based contracting?

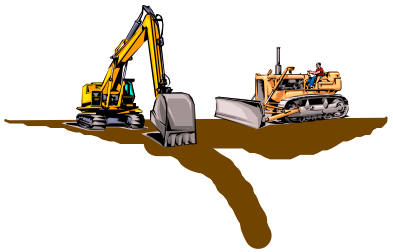
- These answers provide the basis for:
  - Ensuring appropriate focus on Environmental Restoration problem sets in light of program priorities.
  - Identifying Environmental Restoration program requirements[2] for the Office of Science and Technology.

[1] Commercial practice is used here to mean technologies that have been used and proven in one or more decommissioning projects by any sector (government, private, foreign, etc.) and the cost and performance data have been documented.

[2] Program requirements are defined as problem sets for which there is no commercial practice or commercial practice needs improvement.

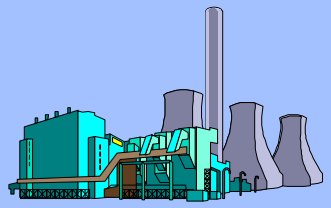
ENVIRONMENTAL RESTORATION PROBLEM SETS

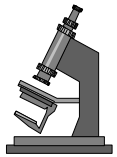
Remediation



Waste Processing

Decommissioning





Characterization/Monitoring

The Short Answer...

THE PRESENT ANALYSIS FOCUSES ON DECOMMISSIONING, WHICH COMPRISES 23 PROBLEM SETS DEFINED BY MEDIA AND CONTAMINANTS

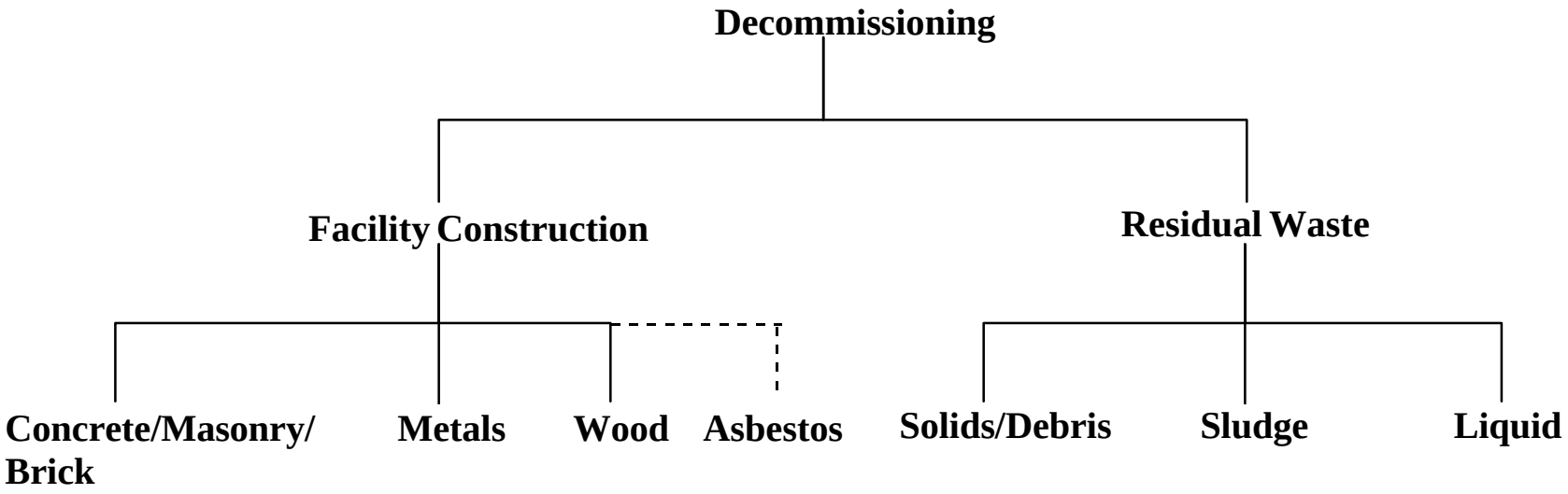
- Media and contaminants define the problem sets because they are the principal parameters in technology selection.

- Decommissioning problem sets correspond to the facilities addressed by decontamination and decommissioning actions.

	Facility Construction				Residual Waste		
Contaminants / **Media**	Metals	Concrete/Masonry/ Brick	Wood Products	Asbestos	Solids/Debris	Sludge	Liquid
Organic	○				○		
Energetics[1]					☆		
Organic/Inorganic					◑		
Inorganic	●			●	●		
Radioactive	▽	▽	▽	▽	▽	▽	▽
Mixed LLW	▼				▼		
Mixed TRU	△				△		
Sanitary[2]	▭	▭	▭		▭		
Unspecified[3]					*		

[1] Energetics are defined as elements or compounds subject to explosive reactions, or residual contamination associated with the past use, storage, treatment, or disposal of such material (such as ordnance) including byproducts or breakdown products.
[2] Sanitary includes demolition waste, waste that may be associated with contaminated sources but not itself contaminated, and waste contaminated at low levels.
[3] This problem set comprises an unknown quantity of unspecified contaminants in solids/debris at one site.
Source: EM-40 Core Database, July 30, 1996

DECOMMISSIONING PROBLEM SET HIERARCHY



The Short Answer...

THE DECOMMISSIONING PROBLEM SETS ARE CATEGORIZED FOR THIS ANALYSIS AS FACILITY CONSTRUCTION OR RESIDUAL WASTE

- The facility construction category includes metals, concrete/masonry/brick, wood products, and asbestos problem sets which are commonly associated with decontaminating, cutting/sizing, or demolishing facilities.

- Solids/debris, sludge, and liquids problem sets are grouped into residual waste, because they are assumed to be secondary wastes that are currently in inventory from decommissioning facilities rather than in-place building materials.

- Asbestos presents a unique situation in that this problem set fits into the facility construction category but is commonly treated ex situ, similar to residual waste; therefore, for the purposes of this analysis, asbestos is considered to be a facility construction problem set that is treated as residual waste.

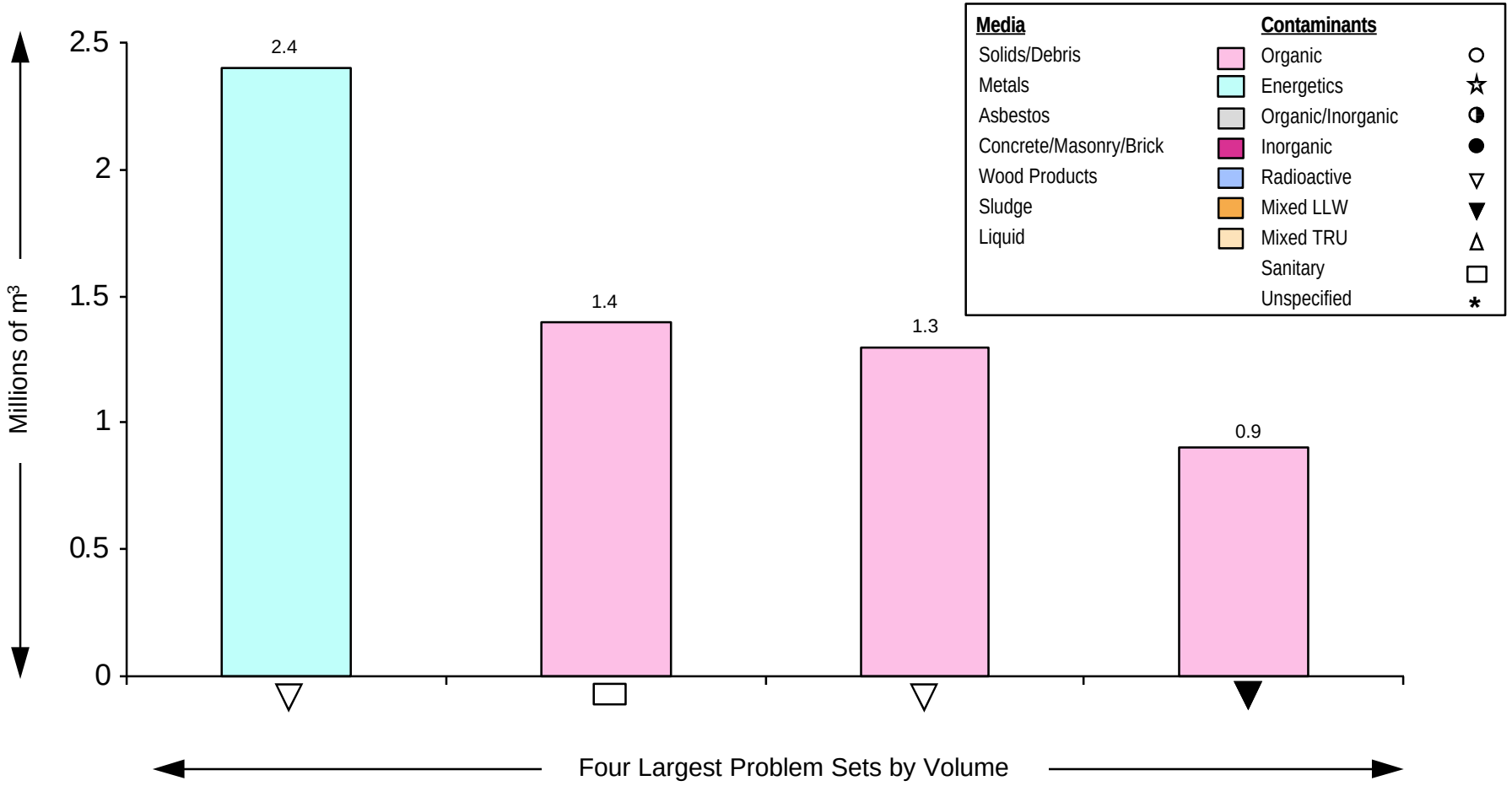
- Assumptions and limitations regarding the problem sets are detailed in the Introduction and Appendix A of this report.

The Short Answer...

METALS AND SOLIDS/DEBRIS DOMINATE THE PROBLEM SETS AS MEASURED BY VOLUME OF CONTAMINATED MEDIA

- Total volume in 23 problem sets: 6.3 million m^3.

- Four problem sets account for 97% of the volume (6.1 million m^3).

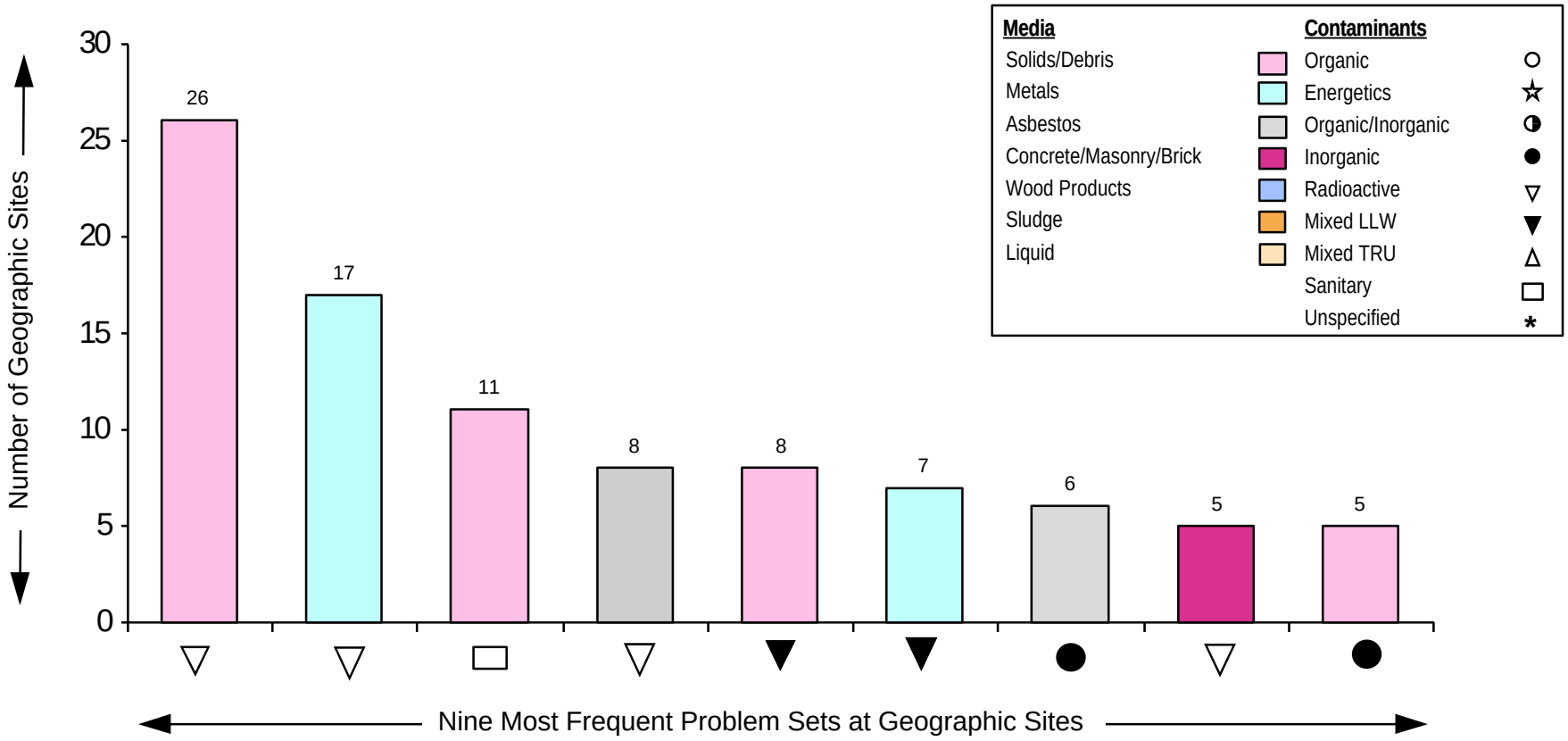


Source: EM-40 Core Database, July 30, 1996

The Short Answer...

THE DISTRIBUTION OF PROBLEM SETS BY GEOGRAPHIC SITES IS WEIGHTED TOWARD RADIOACTIVE, INCLUDING MLLW, CONTAMINATION, ESPECIALLY IN SOLIDS/DEBRIS AND METALS

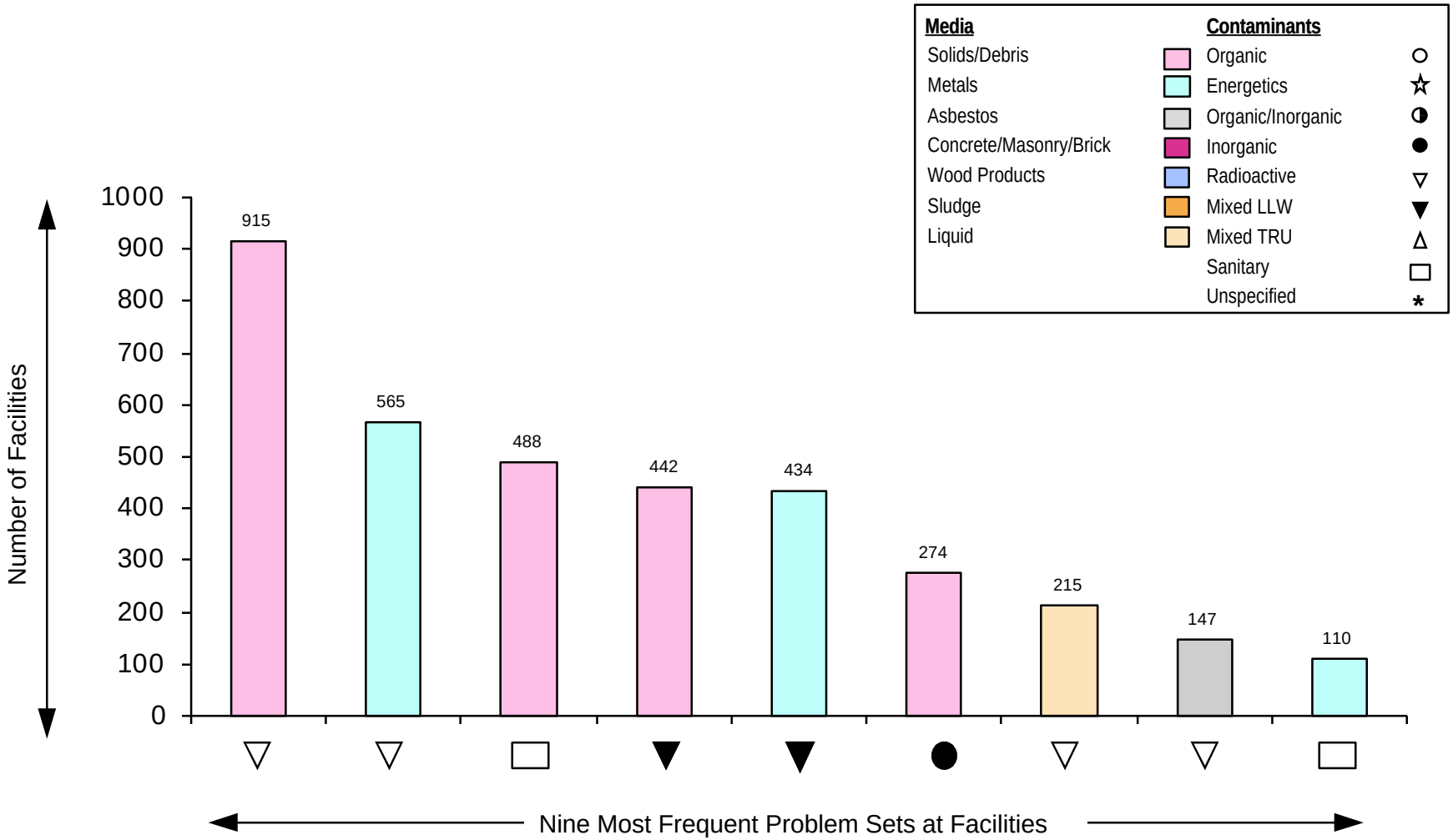
- 132 geographic sites in Environmental Restoration Program.
- 36 geographic sites have one or more decommissioning problem sets.



Source: EM-40 Core Database, July 30, 1996

The Short Answer...

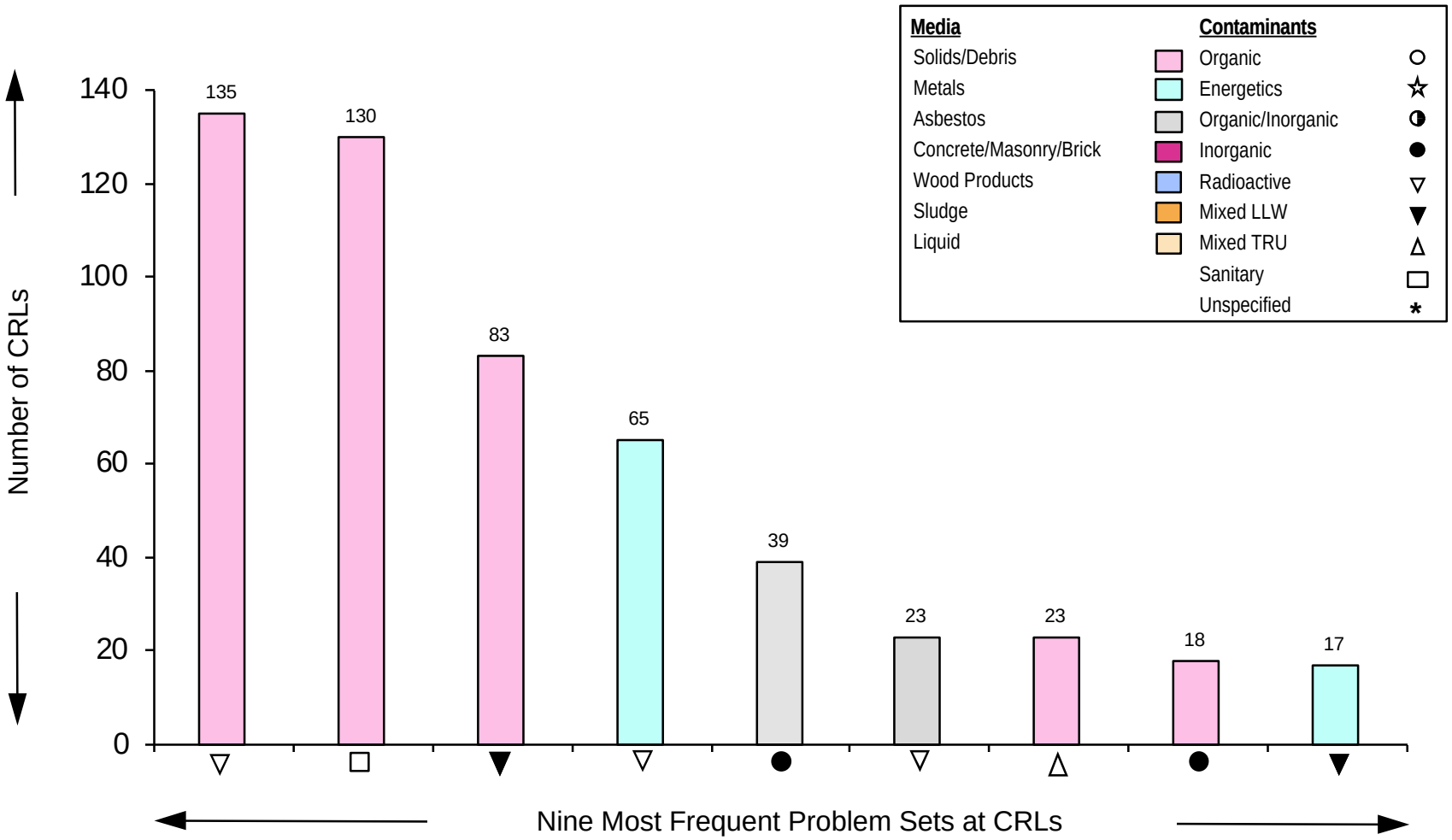
MUCH LIKE THE GEOGRAPHIC DISTRIBUTION, SOLIDS/DEBRIS AND METALS WITH RADIOACTIVE, INCLUDING MLLW, CONTAMINATION DOMINATES THE FACILITY DISTRIBUTION



Source: EM-40 Core Database, July 30, 1996

The Short Answer...

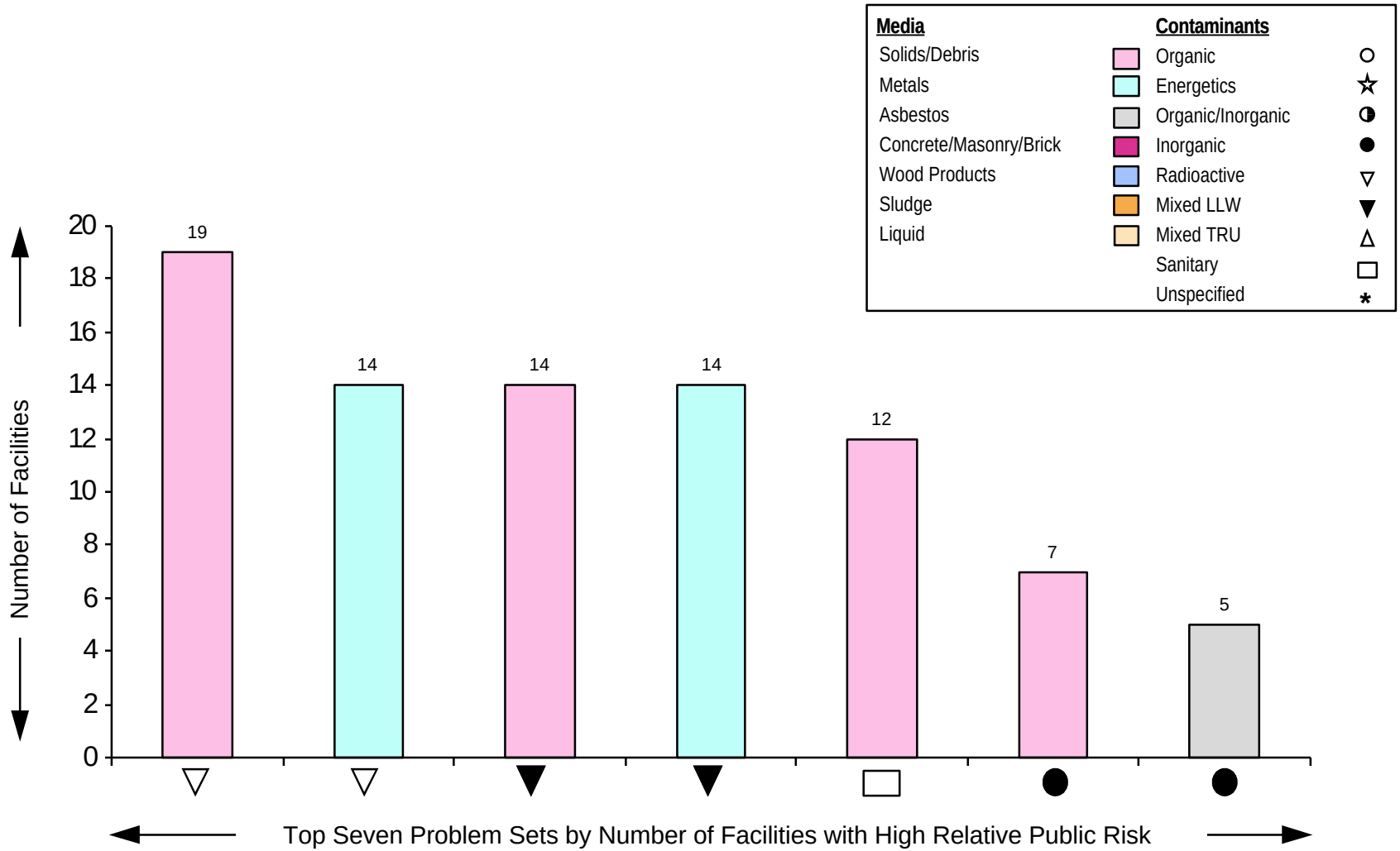
THE DISTRIBUTION OF PROBLEM SETS AT THE CORE DATABASE REPORTING LEVEL (CRL) SHOWS DOMINANCE OF SOLIDS AND DEBRIS



Source: EM-40 Core Database, July 30, 1996

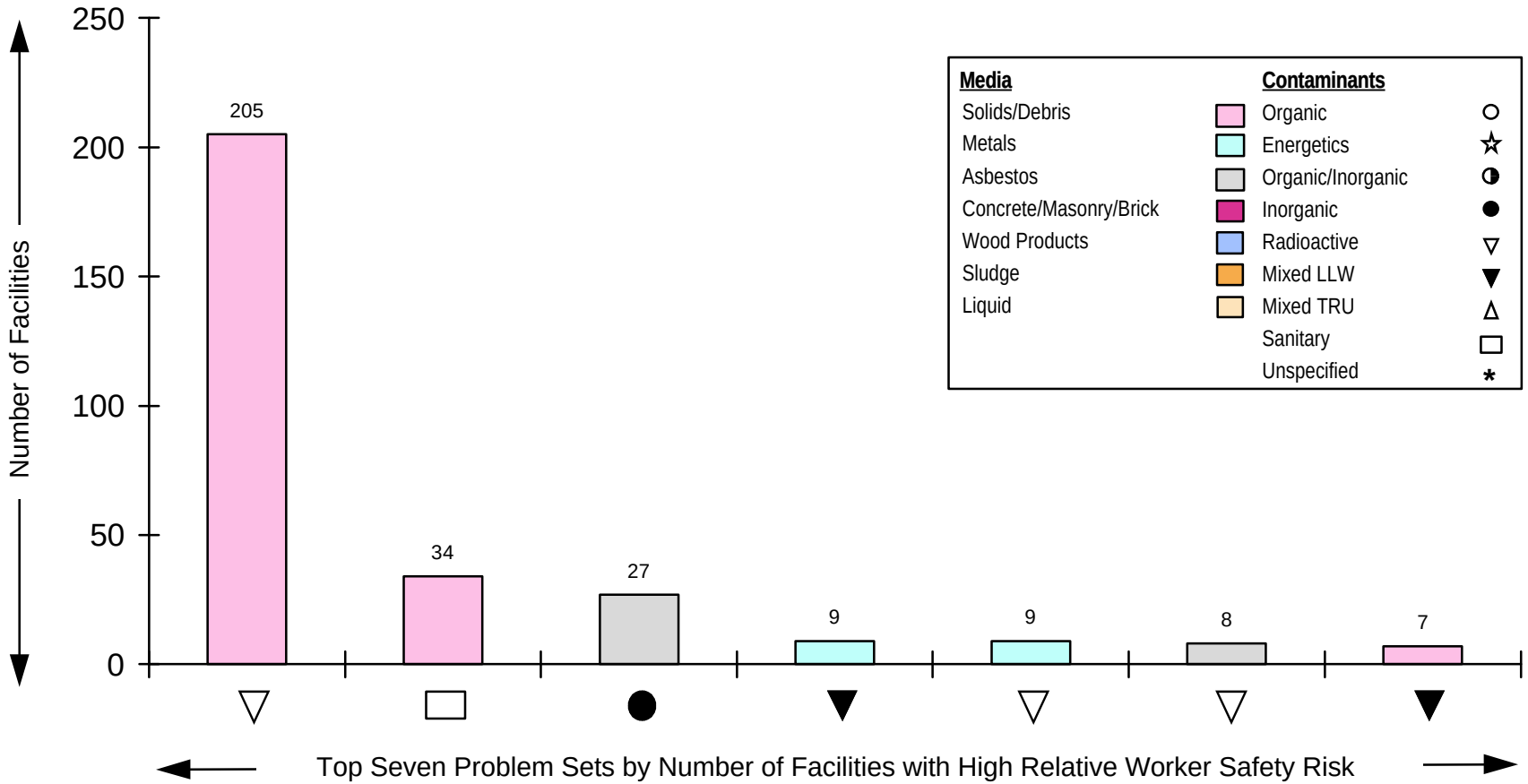
The Short Answer...

SOLIDS/DEBRIS AND METALS DOMINATE THE DISTRIBUTION OF FACILITIES WITH HIGH RELATIVE RISK TO THE PUBLIC



Source: EM-40 Core Database, July 30, 1996

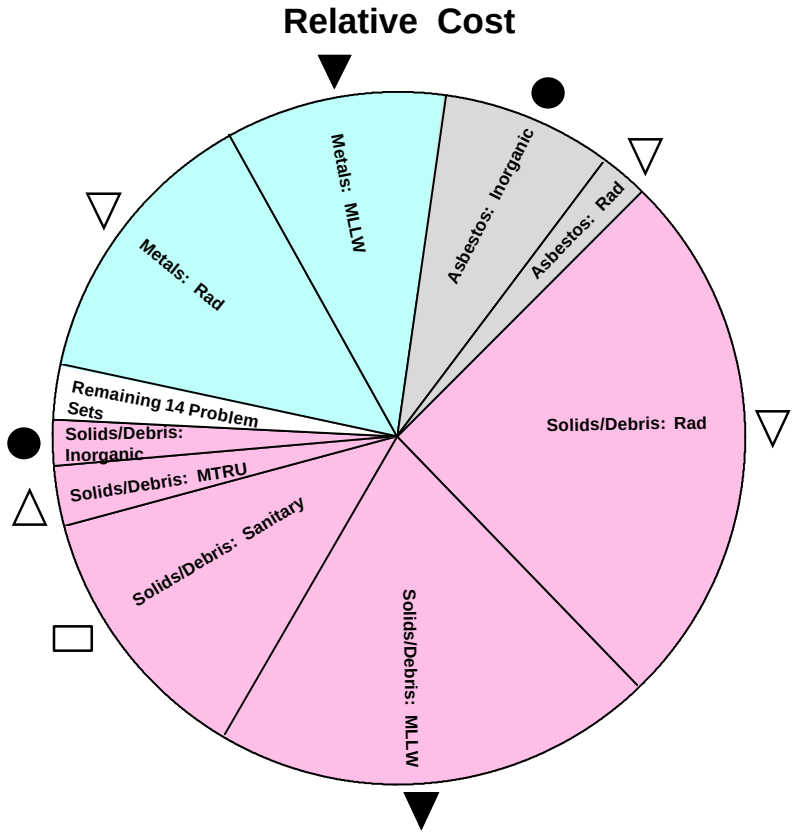
INCIDENCE OF FACILITIES WITH HIGH RELATIVE RISK FOR WORKER SAFETY IS SIGNIFICANTLY HIGHER THAN PUBLIC RISK



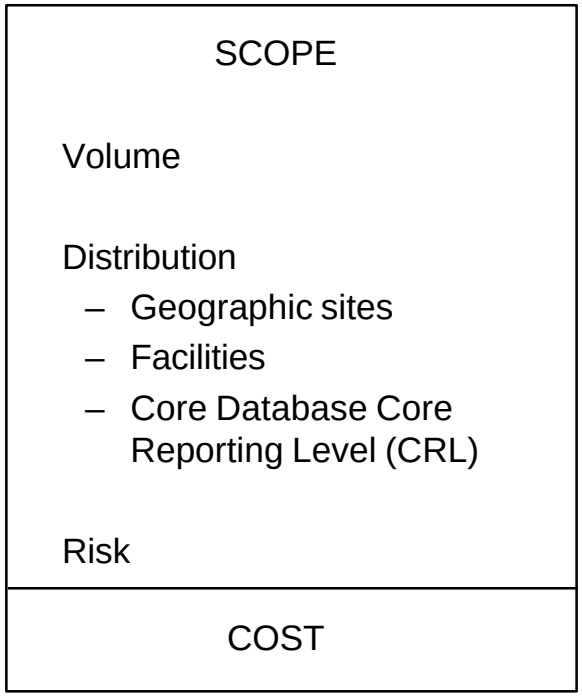
Source: EM-40 Core Database, July 30, 1996

WITHIN THE LIMITATIONS OF THE DATA, NINE PROBLEM SETS APPEAR TO ACCOUNT FOR THE MAJORITY OF COSTS, WHILE COSTS FOR THE REMAINING 14 PROBLEM SETS APPEAR RELATIVELY SMALL

- Based on the 1996 Baseline Environmental Management Report (BEMR) projections, about $20.8 billion will be required for decommissioning, so cost could be a consideration in identifying high priority problem sets.
- The Core Database contains 217 CRLs that are associated with the 23 decommissioning problem sets.
- The Core Database contains 60 instances of CRLs comprising a single problem set, which permits a direct link between CRL cost and a problem set; remaining CRL/cost relationships cannot be directly linked.
- Without a direct link between problem sets and costs, cost impacts cannot be estimated reliably, and given the variability in the relationships among problem sets and costs, attempts to aggregate or compare the available cost data could produce misleading results.
- Within the limitations of the data, solids/debris problem sets account for over half the relative costs.



DIMENSIONS FOR FIRST-ORDER RELATIVE RANKING OF PROBLEM SETS



The Short Answer...

COMPARISON OF THE PROBLEM SETS ACROSS THE DIFFERENT DIMENSIONS SHOWS THAT EIGHT PROBLEM SETS PREDOMINATE CONSISTENTLY

- Problem sets are arranged in the table according to their rank across and within all of the dimensions.
- Four problem sets in total account for the top three problem sets in six of the seven dimensions.
- Solids/debris and metals contamination predominates in all problem sets.
- Radioactive contaminants, including mixed LLW, are the most widely represented contaminants in the problem sets.

Problem Set	Rank Within Dimension						
	Volume	Geo. Site Dist.	Facility Dist.	CRL Dist.	Relative Risk Dist. PS	Relative Risk Dist. WKR	Relative Cost
Solids/Debris - Radioactive	3	1	1	1	1	1	1
Metals - Radioactive	1	2	2	4	2 [1]	4 [1]	3
Solids/Debris - Sanitary	2	3	3	2	5	2	4
Solids/Debris - Mixed LLW	4	4 [1]	4	3	2 [1]	7	2
Metals - Mixed LLW	6	6	5	9	2 [1]	4 [1]	5
Asbestos - Inorganic	5	7	-	5	7	3	6
Asbestos - Radioactive	9	4 [1]	8	6	-	6	8
Solids/Debris - Inorganic	8	8	6	8	6	-	9

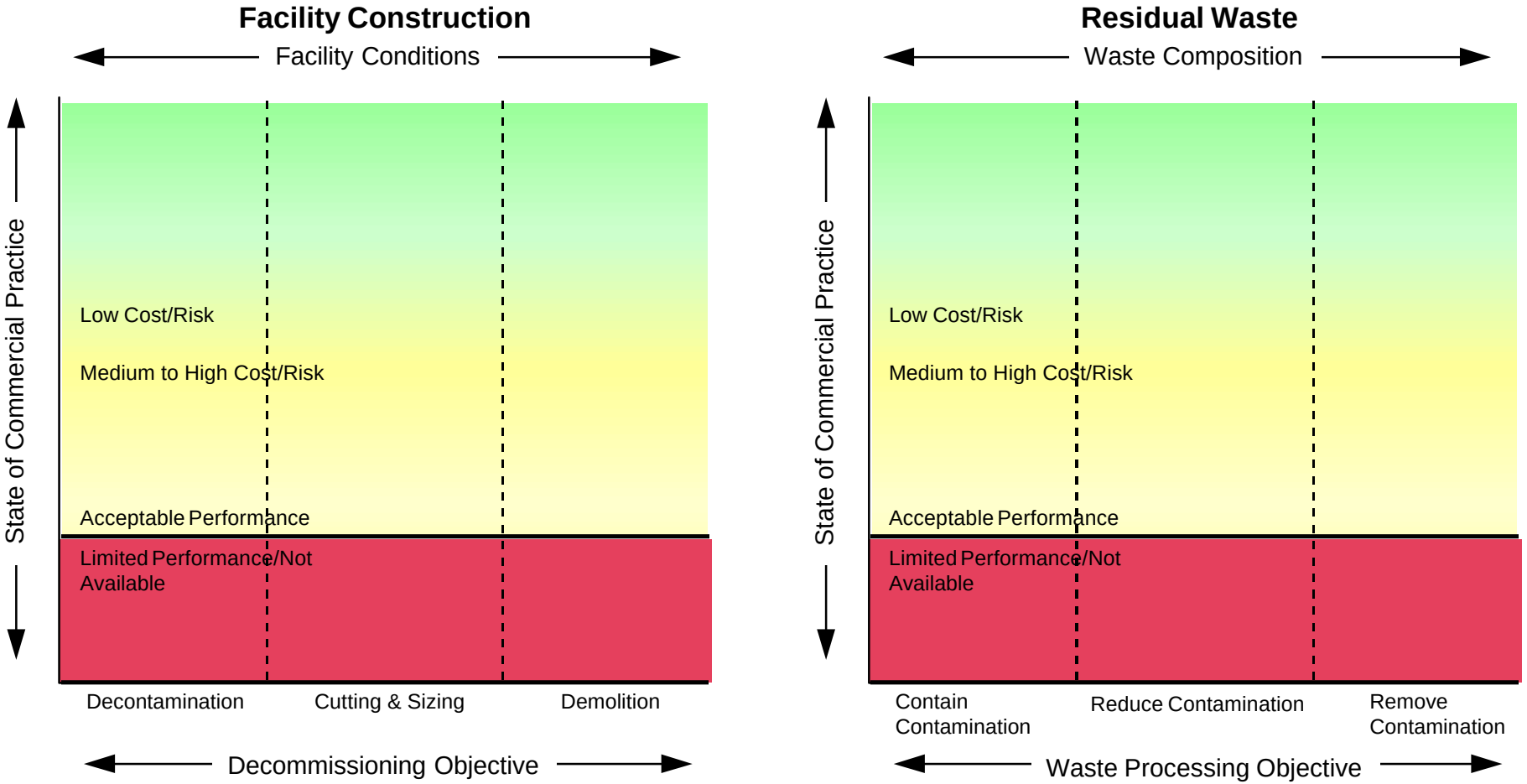
PS = public safety and WKR = worker safety

"-" means below top five problem sets in that dimension

[1] Denotes a tie

Ranking: 1 → 9 (highest → lowest)

- Facility conditions and waste composition are a set of conditions that affect technology performance and selection (e.g., presence of mercury, size of piping).
- Facility conditions in the PAM were derived from the Decommissioning Benchmarking Final Report, January 15, 1997 (see Introduction).
- Assumptions and limitations regarding the conditions are detailed in the Introduction and Technology Screening Analysis sections of this report.



CLEANUP OBJECTIVES AND THE STATE OF COMMERCIAL PRACTICE DETERMINE HOW WELL A GIVEN TECHNOLOGY SATISFIES THE ENVIRONMENTAL CONDITIONS ASSOCIATED WITH PROBLEM SETS

- The Environmental Restoration Program needs information about commercial practice in order to:
  - Identify and articulate technology requirements for completing site restoration.
  - Identify where performance-based contracting can keep cleanup costs down.
  - Identify problem sets where policy and/or regulatory issues impede performance.

- This framework depicts the analytic model used to assess commercially-available technologies identified in the Preferred Alternatives Matrix (PAM) with respect to Environmental Restoration problem sets.

- The shaded areas of the figure represent the state of commercial practice, given the cleanup objective and environmental conditions associated with problem sets.

- The green-yellow area indicates the availability of low cost/risk technologies that satisfy a given problem set, with declining degrees of acceptability as the technology cost and/or risk rises.

- The shift from yellow to red marks the “bright line” between marginal performance and the complete absence of an acceptable solution.

- The model also highlights areas where performance-based contracting is effective and desirable, with the green range presenting clear-cut opportunities for cost and performance improvements and the yellow range offering more modest prospects.

PREFERRED ALTERNATIVES MATRIX TECHNOLOGY RANKING CRITERIA

Rank	Title	Criteria
●	Preferred alternative	Technology is commercially available in this application. Lowest cost, best performance, and low risk.
◕	Probable alternative	Technology is commercially available in this application. Low cost, good performance, and low risk.
◑	Potential alternative	Technology is commercially available in this application. Acceptable performance, but medium cost and/or medium risk.
◔	Possible alternative	Technology is commercially available. High cost or high risk (e.g., not proven in this application).
○	Unlikely	Technology is commercially available. Limited performance or high cost or high risk.
⊗	Not applicable	

Best

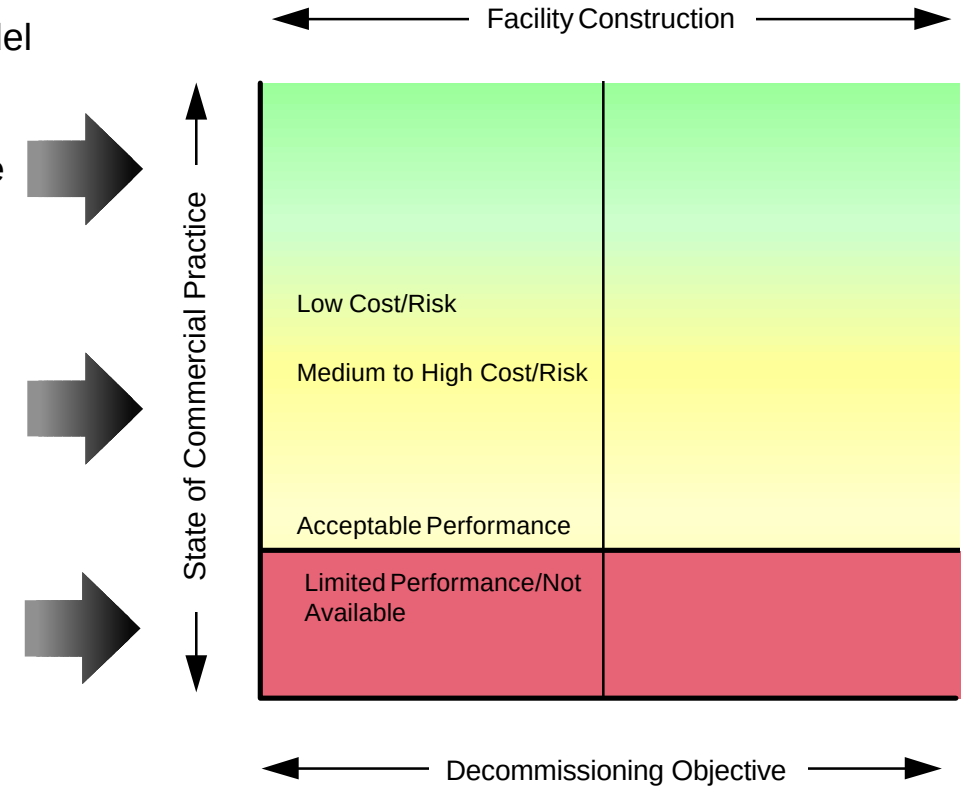
Cost
Risk
Performance

Worst

PAM SCORES PROVIDE AN INITIAL BASIS FOR MAPPING COMMERCIALLY-AVAILABLE TECHNOLOGIES TO PROBLEM SETS

- The PAMs subjectively rank commercially available technologies on the basis of performance, cost, and risk; the PAMs will become more objective as cost and performance reports are developed and the results incorporated into the PAMs.

- The PAM scores were mapped to the model as follows:
  - Green: More than one preferred or probable alternative[1]
  - Yellow: Only one preferred or probable alternative or more than one potential or possible alternative[1]
  - Red: Only one potential or possible alternative or only unlikely or not applicable alternatives



[1] Analysis of disposal did not include the "more than one" criteria; for example, if only one preferred or probable alternative is available, disposal would map to green.

THE MODEL ALLOWS HIGH-LEVEL CONCLUSIONS TO BE DRAWN BY AGGREGATING RESULTS INTO PIE CHARTS

- Decontamination, cutting and sizing, demolition, and ex situ treatment can be compared across problem sets of same media by evaluating the analytical model.

- As seen in the example methodology diagram, the results for cutting and sizing of metals (5 green) are aggregated to form a summary pie chart (100% green).

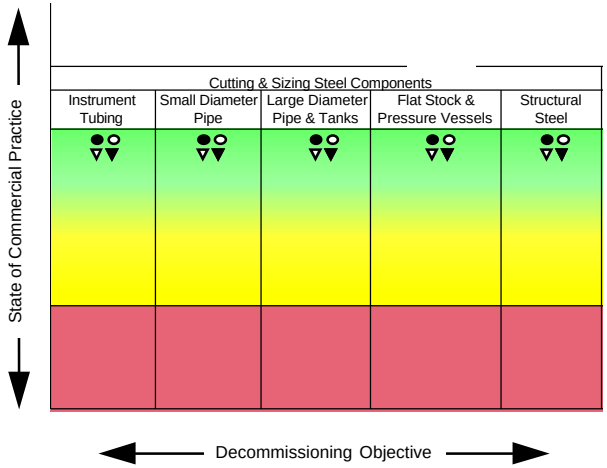
- In this fashion, it can be concluded that cutting and sizing of metals is satisfied by commercial practice and there are numerous opportunities for performance-based contracting.

The Short Answer...

METHODOLOGY FOR TECHNOLOGY ANALYSIS

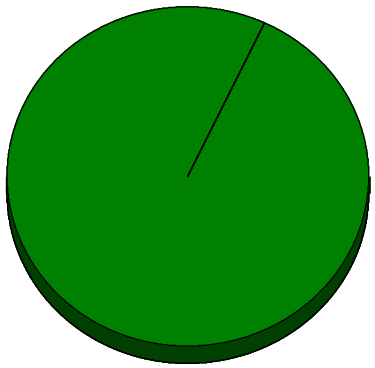
Example: Cutting and Sizing of Metals

CUTTING/SIZING OF METALS



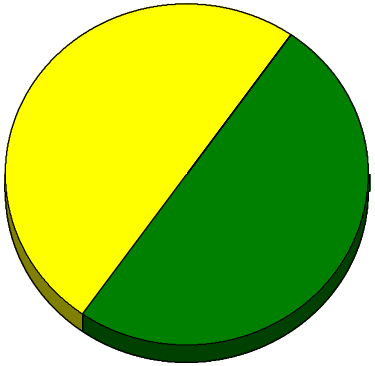
No. of facility conditions with the state of commercial practice in:
5 Green
0 Yellow
0 Red

Cutting/Sizing of Metals

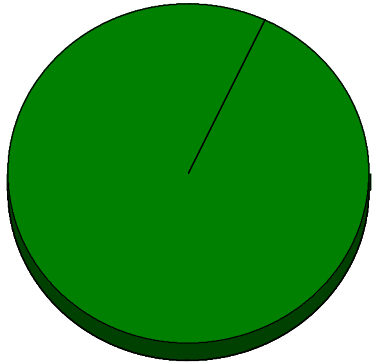


SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR CONCRETE/MASONRY/BRICK PROBLEM SETS[1]

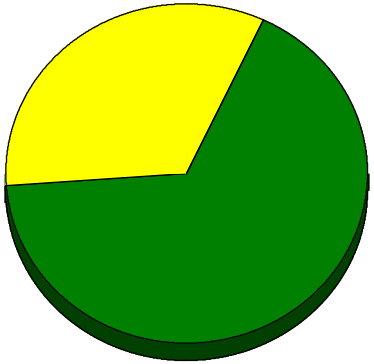
Decontamination



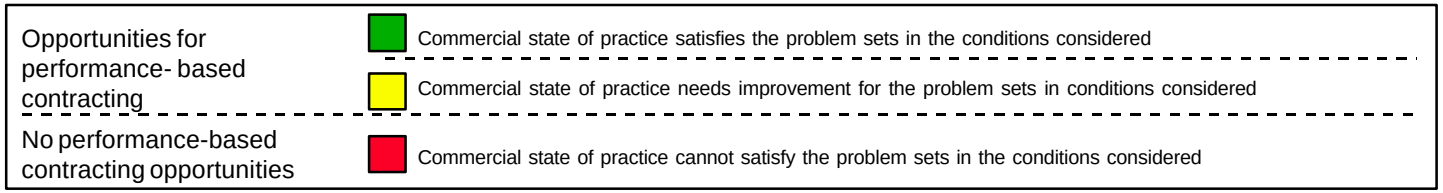
Cutting & Sizing



Demolition



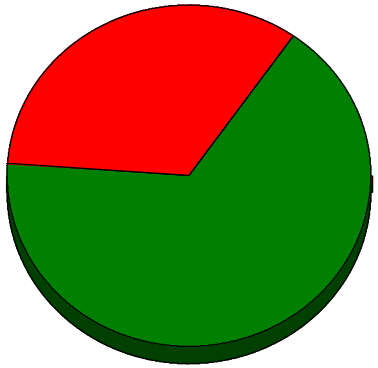
- Commercial practice is available for all conditions considered for cutting and sizing and improvements are necessary in some cases for decontamination and demolition.
- Performance-based contracting opportunities exist for all three phases considered for decommissioning of concrete/masonry/brick.



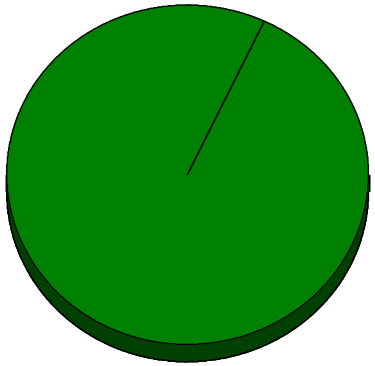
[1] Pie charts represent percentage of conditions in the PAM in which concrete/masonry/brick problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR METALS PROBLEM SETS[1]

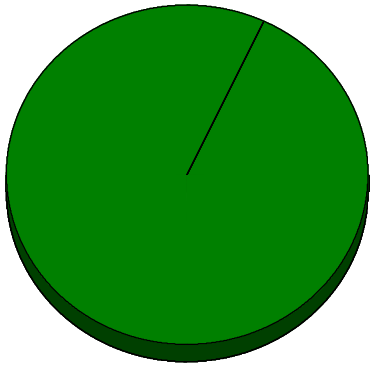
Decontamination



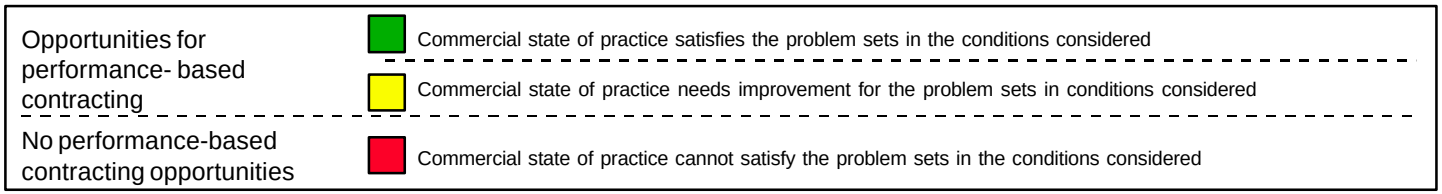
Cutting & Sizing



Demolition



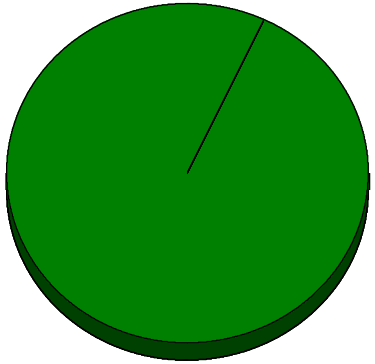
- Commercial practice is available for all conditions considered for cutting and sizing and demolition and is lacking for approximately one-third of the decontamination conditions.
- Numerous performance-based contracting opportunities exist for decontamination, cutting and sizing, and demolition.



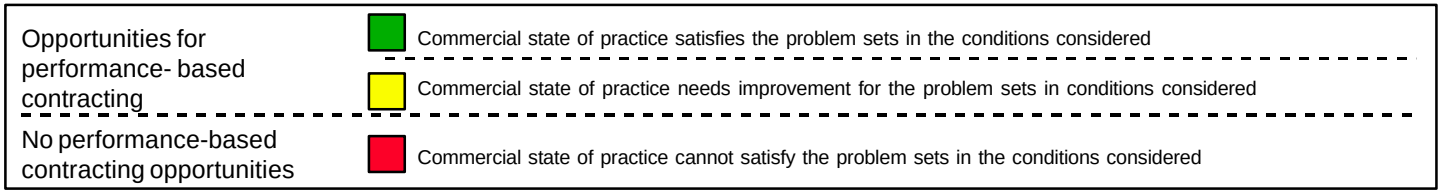
[1] Pie charts represent percentage of conditions in the PAM in which metals problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR WOOD PROBLEM SETS[1]

Demolition



- Commercial practice is available for all conditions considered for demolition of wood.
- Likewise, performance-based contracting opportunities exist for all conditions considered.

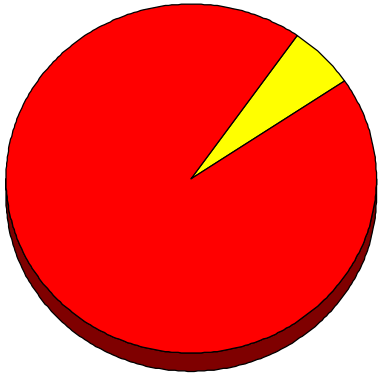


[1] Pie charts represent percentage of conditions in the PAM in which wood problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

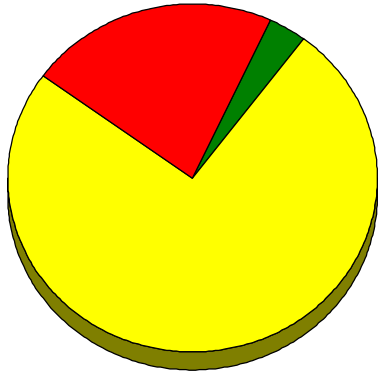
The Short Answer...

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR SOLIDS/DEBRIS PROBLEM SETS[1]

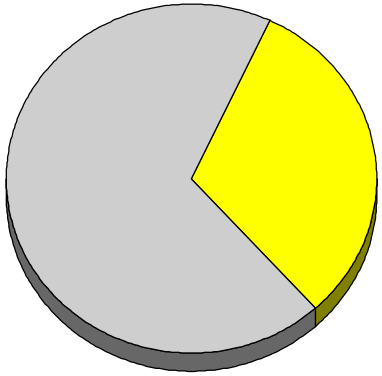
Stabilization



Treatment

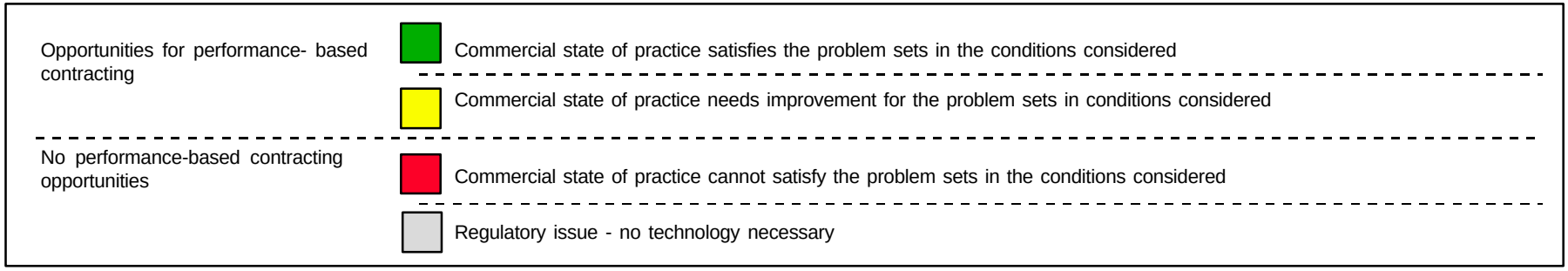


Disposal



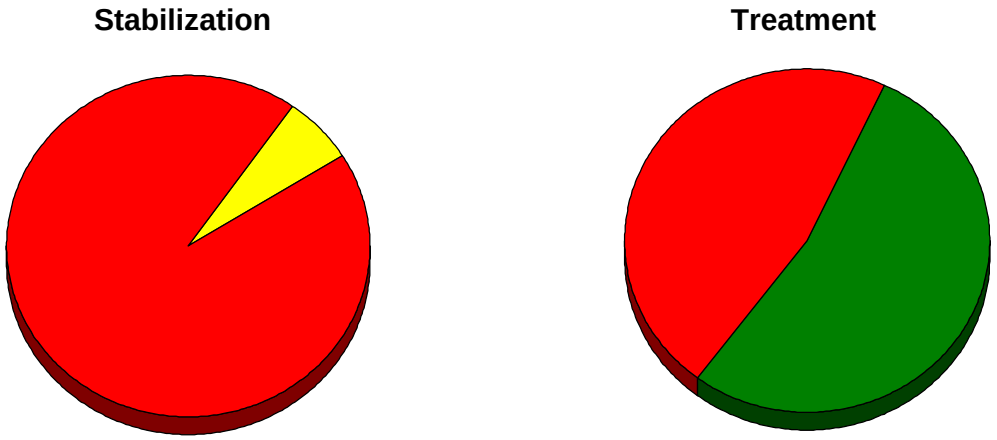
- Commercial practice does not resolve solids/debris for the majority of conditions using stabilization or disposal techniques; conversely, there are many available practices for treatment, though improvement is necessary.

- Treatment offers numerous performance-based contracting opportunities with stabilization and disposal presenting far fewer opportunities.



[1] Pie charts represent percentage of conditions in the PAM in which solids/debris problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE ASBESTOS PROBLEM SETS[1,2]



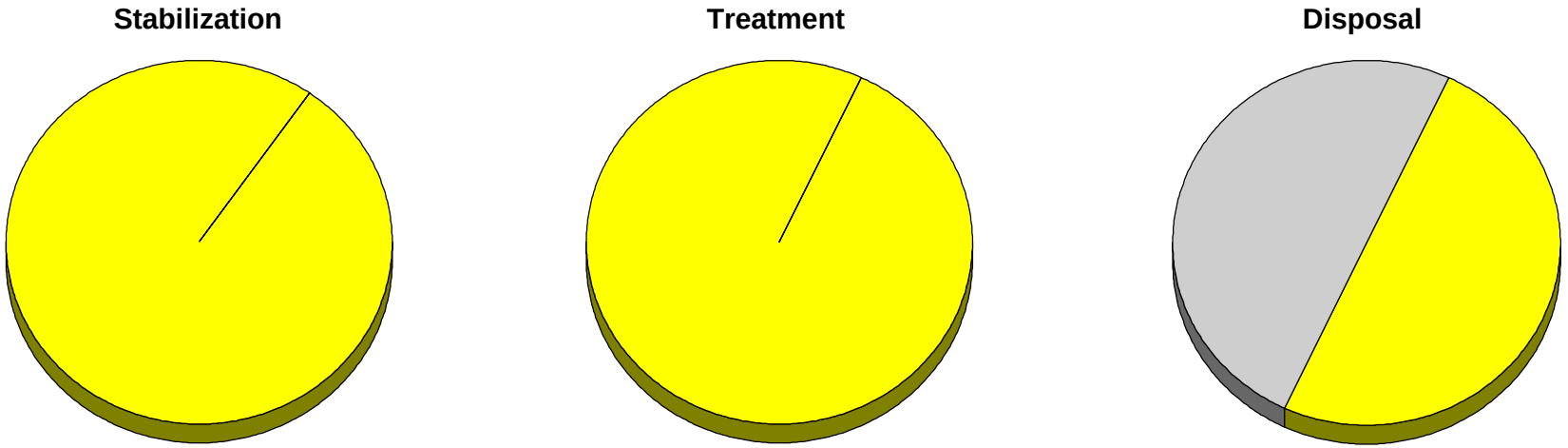
- Treatment offers promising alternatives for over half of the conditions considered, and stabilization provides almost no prospects.
- Likewise, treatment has the best prospects for performance-based contracting.

Opportunities for performance- based contracting		Commercial state of practice satisfies the problem sets in the conditions considered
		Commercial state of practice needs improvement for the problem sets in conditions considered
No performance-based contracting opportunities		Commercial state of practice cannot satisfy the problem sets in the conditions considered

[1] Pie charts represent percentage of conditions in the PAM in asbestos problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

[2] Low-cost/risk alternatives are assumed to be available

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE SLUDGE PROBLEM SET[1]



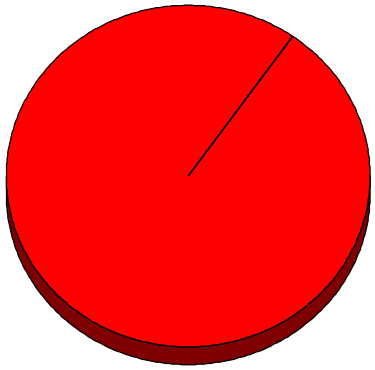
- Stabilization, treatment, and disposal are areas needing significant improvement for sludge.
- All conditions considered for treatment and stabilization offer performance-based contracting opportunities, but there are fewer opportunities for disposal.

Opportunities for performance- based contracting	Commercial state of practice satisfies the problem sets in the conditions considered
	Commercial state of practice needs improvement for the problem sets in conditions considered
No performance-based contracting opportunities	Commercial state of practice cannot satisfy the problem sets in the conditions considered
	Regulatory issue - no technology necessary

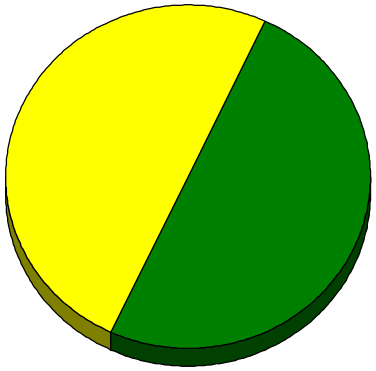
[1] Pie charts represent percentage of conditions in the PAM in sludge problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE LIQUIDS PROBLEM SET[1]

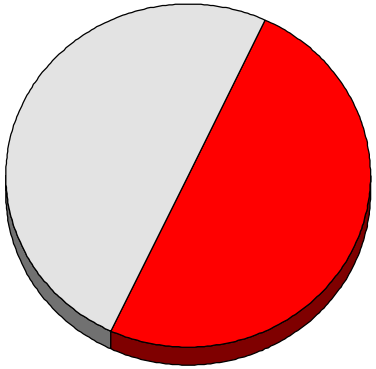
Stabilization



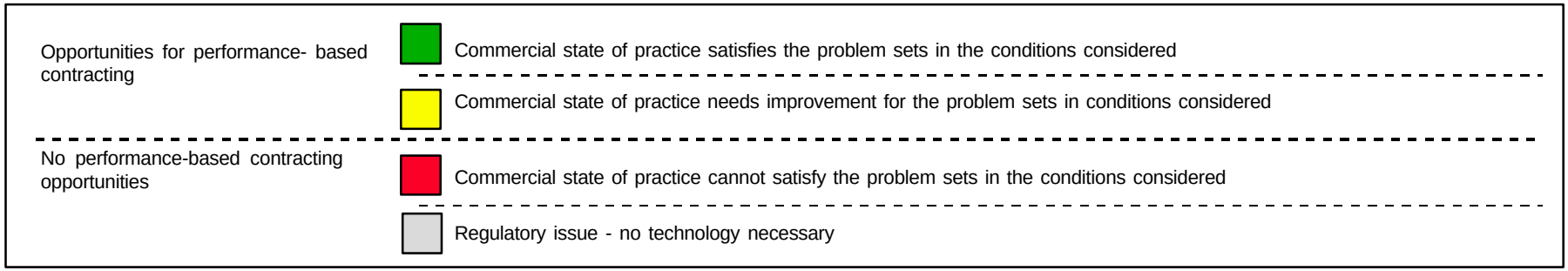
Treatment



Disposal



- Treatment is the only alternative for liquids problem sets as stabilization and disposal offer no prospects.
- Likewise, treatment is the only opportunity for performance-based contracting.



[1] Pie charts represent percentage of conditions in the PAM in liquids problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

The Short Answer...

THE DETAILED REQUIREMENTS DEFINITIONS AS WELL AS OTHER RELATED INITIATIVES CAN BE FOUND ON THE EM HOMEPAGE

- The full text is available on the Internet for the following requirements definition documents:
  - Volume IA: Remediation
  - Volume IB: Waste Processing
  - Volume IC: Decommissioning
  - Volume ID: Characterization/Monitoring
  - Volume II: Problem Sets Definition

- In addition, the following items can be found at the same location:
  - Remediation/Waste Processing PAM
  - Decommissioning PAM
  - Characterization/Monitoring PAM
  - Guidance for documenting cost and performance
  - Cost and performance reports and related links

- The address is

  http://www.em.doe.gov/define

THE SHORT ANSWER

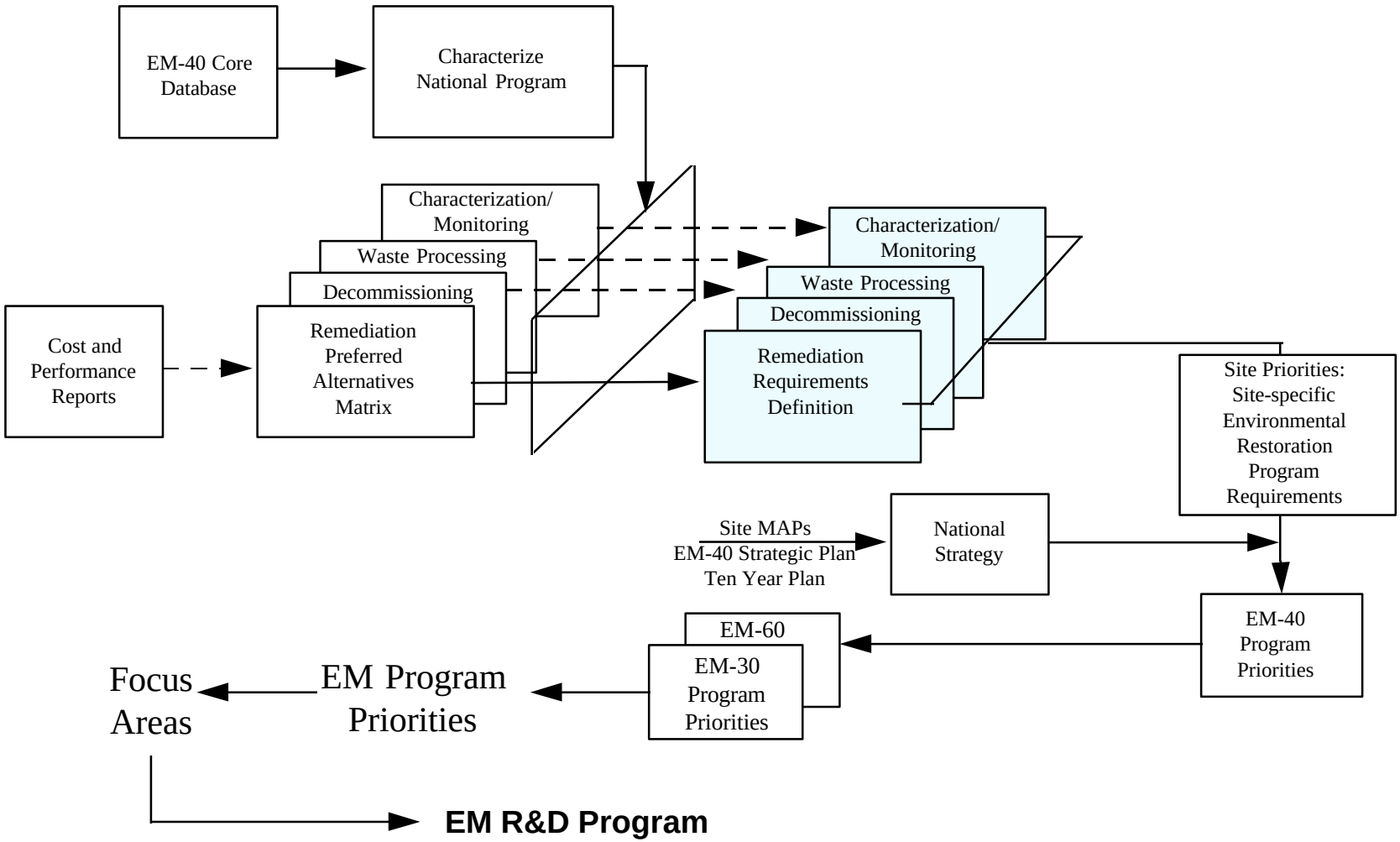
INTRODUCTION

PROBLEM SET DEFINITION

TECHNOLOGY SCREENING ANALYSIS

NEXT STEPS

Development of Overall EM Program Priorities to Assist Technology Development



THIS ANALYSIS SUPPORTS THE ENVIRONMENTAL RESTORATION TECHNOLOGY IMPLEMENTATION GOAL OF "THE RIGHT TECHNOLOGY AT THE RIGHT TIME AT THE RIGHT SITE"

- The Environmental Restoration Requirements Definition, which comprises the shaded area of the figure, defines the problem sets associated with the former weapons complex and assesses whether site restoration technologies are commercially available or need improvement.

- This set of analyses examines the problem sets associated with:
  - Remediation, focused in large part on contaminants in environmental media.
  - Waste processing, comprising waste materials resulting from past operations, and other processes.
  - Decommissioning, primarily focused on residual contaminants in buildings and structures and construction debris.
  - Characterization and monitoring, including all of the above problem sets.

- The Requirements Definition also examines the technologies that are commercially available to address these problem sets and the extent to which problem sets are satisfied by the state of commercial practice[1].

- This report (Volume 1C) analyzes decommissioning problem sets in the Environmental Restoration Program and the technologies for addressing them.

[1] Commercial practice is used here to mean technologies that have been used and proven in one or more decommissioning projects by any sector (government, private, foreign, etc.) and the cost and performance data have been documented.

THE DEFINITION OF DECOMMISSIONING PROBLEM SETS IS BASED ON THE EM-40 CORE DATABASE

- The Core Database contains Environmental Restoration cost and inventory data provided initially by the DOE field elements for the 1996 Baseline Environmental Management Report (BEMR) and other purposes and has been substantially updated and expanded.

- Problem sets for decommissioning were extracted from the Core Database by using the media category of “structures and equipment.”

- The Core Database version of July 30, 1996, was used to define and analyze the problem sets discussed in this analysis.

- Appendix A discusses the Core Database, limitations and assumptions associated with the information it contains, and methods for constructing problem sets based on this information.

- Appendix B contains the Core Database Data Glossary.

THE DECOMMISSIONING BENCHMARKING FINAL REPORT FORMED THE BASIS FOR THE FACILITY CONSTRUCTION CONDITIONS IN THE DECOMMISSIONING PAM

- Jointly sponsored by DOE and the U.S. Environmental Protection Agency, the Decommissioning Benchmarking Final Report, January 15, 1997 (http://www.em.doe.gov/dd/bench.html), focused on decontamination, cutting and size reduction, and demolition tasks since these activities encompass the full range of physical activities required to eliminate hazards from a facility.

- The facility conditions in the PAM are organized to reveal the impact of factors considered in the Decommissioning Benchmarking, namely:
  - accessibility - some technologies may be less suitable in tight spaces, weak structures, and/or in the presence of industrial hazards;
  - airborne contamination/fire hazard - some technologies may result in airborne contamination or elevate the potential for hazard; and
  - exposure - some technologies may not provide adequate radiological protection for workers or, in extreme cases, may not be operable.

THE CORE DATABASE STRUCTURE PRECLUDES ANALYSIS OF ONE-TO-ONE RELATIONSHIPS BETWEEN PROBLEM SETS AND CERTAIN KEY VARIABLES

- The different levels at which the information is reported and collected do not support a direct relationship between problem sets and the cost, facility, and relative risk data that may be associated with them.

- The CRL is the fundamental level of aggregation in the Core Database:
  - Because each site defines what comprises its own CRL, data may not be directly comparable across sites.
  - The CRL is an organizational element that does not necessarily correspond to geographical or functional definitions.
  - As detailed in Appendix A, certain key variables are reported (or linked) only at the CRL, including costs, facilities, and relative risk.

- Limitations and assumptions specific to cost, facilities, and relative risk data are spelled out in the following pages.

CORE DATABASE COST DATA CANNOT BE LINKED DIRECTLY TO PROBLEM SETS, WHICH CONSTRAINS HOW THE COST DATA CAN BE USED TO IDENTIFY PRIORITY PROBLEM SETS

- Identification of priority problem sets needs to consider cost, given the magnitude of potential decommissioning expenditures.

- Because cost data in the Core Database are associated with CRLs, not with problem sets:
  - Cost cannot be assigned to a problem set and aggregated directly to a problem set.
  - Costs cannot be readily compared across problem sets.

- For purposes of this analysis, costs are presented in relative terms only.

- A direct link between problem sets and their expected costs is necessary to accurately weigh priorities among problem sets and is addressed in the “Next Steps.”

FACILITIES AND RELATIVE RISK CANNOT BE LINKED DIRECTLY TO PROBLEM SETS

- Because of the many ways to describe a site, a linkage to facilities is needed to enhance problem set definition.
- Facilities are located in the Release Sites and Facilities section of the Core Database and are linked at the CRL.
- Risk is integral to assessing the urgency of resolving the problem sets; relative risk is linked to facilities in the Database.
- The Core Database contains the “RANKCODE” for every facility, which can be decoded into relative risk for public and worker safety; relative risk for environmental protection cannot be decoded.
- Since the relative risk is at the level of facilities, it is also linked at the CRL.

OTHER LIMITATIONS AND ASSUMPTIONS ALSO APPLY TO THE DEFINITION OF PROBLEM SETS

- Not all volumes of environmental media are fully reported in the Core Database, though efforts are underway to fully populate it; this will tend to understate the affected problem sets.

- Matrix Parameter Codes (MPCs) were used to delineate organic and inorganic contaminant groupings for hazardous waste; in some instances, these contaminants were not clearly specified, which led to an assignment of a more general “organic/inorganic” category.

- The residual wastes solids/debris, sludge, and liquids are assumed to be secondary wastes that were generated in or the result of past decommissioning operations and are currently in inventory; however, it is likely that in some cases facility construction data was reported as solids/debris as this is an all inclusive category.

- Conversely, wood products are assumed to be part of the facility construction but may actually be residual waste in some cases.

- Asbestos presents a unique situation in that this problem set fits into the facility construction category but is commonly treated ex situ, similar to residual waste; therefore, for the purposes of this analysis, asbestos is considered to be a facility construction problem set that is treated as residual waste.

IN ADDITION, SEVERAL LIMITATIONS AND ASSUMPTIONS APPLY TO THE ANALYSIS OF TECHNOLOGIES

- TRU waste is defined as radioactive contamination greater than 100 nCi/g; the technology screening analysis does not consider TRU or high radioactive environments (i.e., remote operations) at this time.

- Sanitary waste is excluded from the PAM and consequently the technology screening analysis, because it is assumed that a low cost/risk disposal alternative is available for waste that is not contaminated or contaminated at low levels.

- For organic/inorganic and mixed LLW it is unlikely that a single technology exists to treat all constituents of the waste, therefore it is assumed that technologies listed in the PAM can be linked to form a treatment train; for example, a technology for organic can be combined with a technology for inorganic to treat organic/inorganic media.

- Low cost pre-treatment is assumed to be available for ex situ treatment.

- “Ex situ treatment” as used in this analysis includes stabilization, thermal and non-thermal treatment, and disposal.

IN ADDITION, SEVERAL LIMITATIONS AND ASSUMPTIONS APPLY TO THE ANALYSIS OF TECHNOLOGIES (CONTINUED)

- It is assumed that wood would not be decontaminated or need specialized technologies for cutting and sizing, therefore dismantlement is the only phase of decommissioning analyzed.
- Disposal and stabilization are only analyzed in <1% total organic concentration (TOC) conditions, because at higher levels, TOC must be reduced via treatment before disposal or stabilization.
- Disposal alternatives for asbestos were not evaluated in the Remediation/Waste Processing PAM for asbestos; however it is assumed that low-cost/risk disposal practices are available.
- Applicability of technologies was used to assess availability; hence, if there are no applicable technologies for a specified environmental condition, it was assumed that there are no available technologies.
- Ex situ treatment can be applied to media in the environment (remediation) as well as materials that have been removed from the environment and stored (waste processing) and produced in decommissioning operations; therefore, the conclusions presented in this report for ex situ treatment are consistent with the requirements definition for waste processing and at a higher level of analysis in the requirements definition for remediation.

THIS ANALYSIS IS EVOLUTIONARY

- Examination of Environmental Restoration problem sets and the technologies for addressing them is the first of a series of analyses which include:
  - Volume 1A: Remediation problem sets and technologies
  - Volume 1B: Waste processing problem sets and technologies
  - Volume 1C: Decommissioning problem sets and technologies (this document)
  - Volume 1D: Characterization/monitoring problem sets and technologies.

- Prioritization of technology requirements will be accomplished through analysis of Ten Year Plans and site needs from Site Technology Coordination Groups.

- The data underlying these analyses will continue to change, as more technologies are deployed.

- Assumptions and hypotheses are subject to modification, based on continuing data collection and analysis; these are detailed in the full version of this report which is located at http://www.em.doe.gov/define.

THE SHORT ANSWER

INTRODUCTION

PROBLEM SET DEFINITION

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NEXT STEPS

THE PRESENT ANALYSIS FOCUSES ON DECOMMISSIONING, WHICH COMPRISES 23 PROBLEM SETS DEFINED BY MEDIA AND CONTAMINANTS

- Media and contaminants define the problem sets because they are the principal parameters in technology selection.

- Decommissioning problem sets correspond to the facilities addressed by decontamination and decommissioning actions.

	Facility Construction				Residual Waste		
Contaminants / **Media**	Metals	Concrete/Masonry/ Brick	Wood Products	Asbestos	Solids/Debris	Sludge	Liquid
Organic	○				○		
Energetics[1]					☆		
Organic/Inorganic					◑		
Inorganic	●			●	●		
Radioactive	▽	▽	▽	▽	▽	▽	▽
Mixed LLW	▼				▼		
Mixed TRU	△				△		
Sanitary[2]	▭	▭	▭		▭		
Unspecified[3]					*		

[1] Energetics are defined as elements or compounds subject to explosive reactions, or residual contamination associated with the past use, storage, treatment, or disposal of such material (such as ordnance) including byproducts or breakdown products.
[2] Sanitary includes demolition waste, waste that may be associated with contaminated sources but not itself contaminated, and waste contaminated at low levels.
[3] This problem set comprises an unknown quantity of unspecified contaminants in solids/debris at one site.
Source: EM-40 Core Database, July 30, 1996

THE DECOMMISSIONING PROBLEM SETS ARE CATEGORIZED AS FACILITY CONSTRUCTION OR RESIDUAL WASTE

- The facility construction category includes metals, concrete/masonry/brick, wood products, and asbestos problem sets which are commonly associated with decontaminating, cutting/sizing, or demolishing facilities.

- Solids/debris, sludge, and liquids problem sets are grouped into residual waste, because they are assumed to be secondary wastes from decommissioning that are currently in inventory rather than in-place building materials.

- Asbestos presents a unique situation in that this problem set fits into the facility construction category but is commonly treated ex situ, similar to residual waste; therefore, for the purposes of this analysis, asbestos is considered to be a facility construction problem set that is treated as residual waste.

- Assumptions and limitations regarding the problem sets are detailed in the Introduction and Appendix A of this report.

STATISTICS AND OTHER INFORMATION DERIVED FOR EACH PROBLEM SET ESTABLISH THE PROBLEM SETS' RELATIONSHIP TO THE ENVIRONMENTAL RESTORATION PROGRAM

Statistic	Indicator For	Comments
– Geographic site distributions – Core reporting level (CRL) distribution – Facilities distribution	– Pervasiveness within the complex	– CRLs with multiple waste streams were counted in each applicable problem set
– Relative cost of problem set	– Relative effort expended on problem set – Potential cost savings	– Due to limitations of CRLs, cost reported as relative
– Public safety risk – Worker safety risk	– Relative risk	– Relative risk reported at facility level and aggregated at the CRL
– Volume of contaminated media	– Size of the problem	– Volume represents cubic meters of contaminated media
– Principal contaminants	– Typical contaminants represented by problem set	– Ten most pervasive contaminants listed as examples
– Response strategy/response description – Comparison to Preferred Alternative Matrix (PAM)	– Technology baseline response – Preferred alternative usage – Technology gaps/areas needing improvement – Opportunities for performance-based contracting	– Evaluate typical response and preferred alternative. Used in conjunction with PAM, can indicate areas for technology development or opportunities for performance-based contracting.

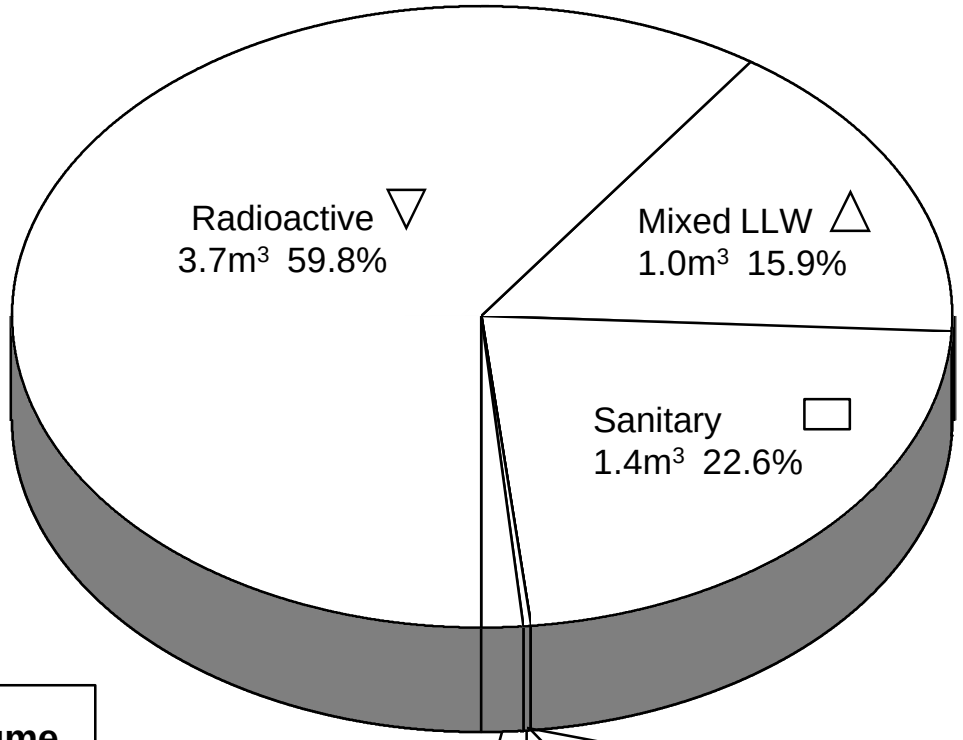
ANALYSIS OF THE DECOMMISSIONING PROBLEM SETS CONSIDERS SCOPE AND COST

- Scope
  - Volume
  - Geographic sites (of 132 geographic sites in the Environmental Restoration Program, 36 have one or more decommissioning problem sets[1])
  - Facilities (specific sources of contamination)
  - Core Database CRLs (fundamental level of data aggregation in the Core Database, as defined by each site originating the data)
  - Risk, as indicated in the Core Database as relative risk of facilities

- Relative cost

[1]Completed sites are excluded from this analysis

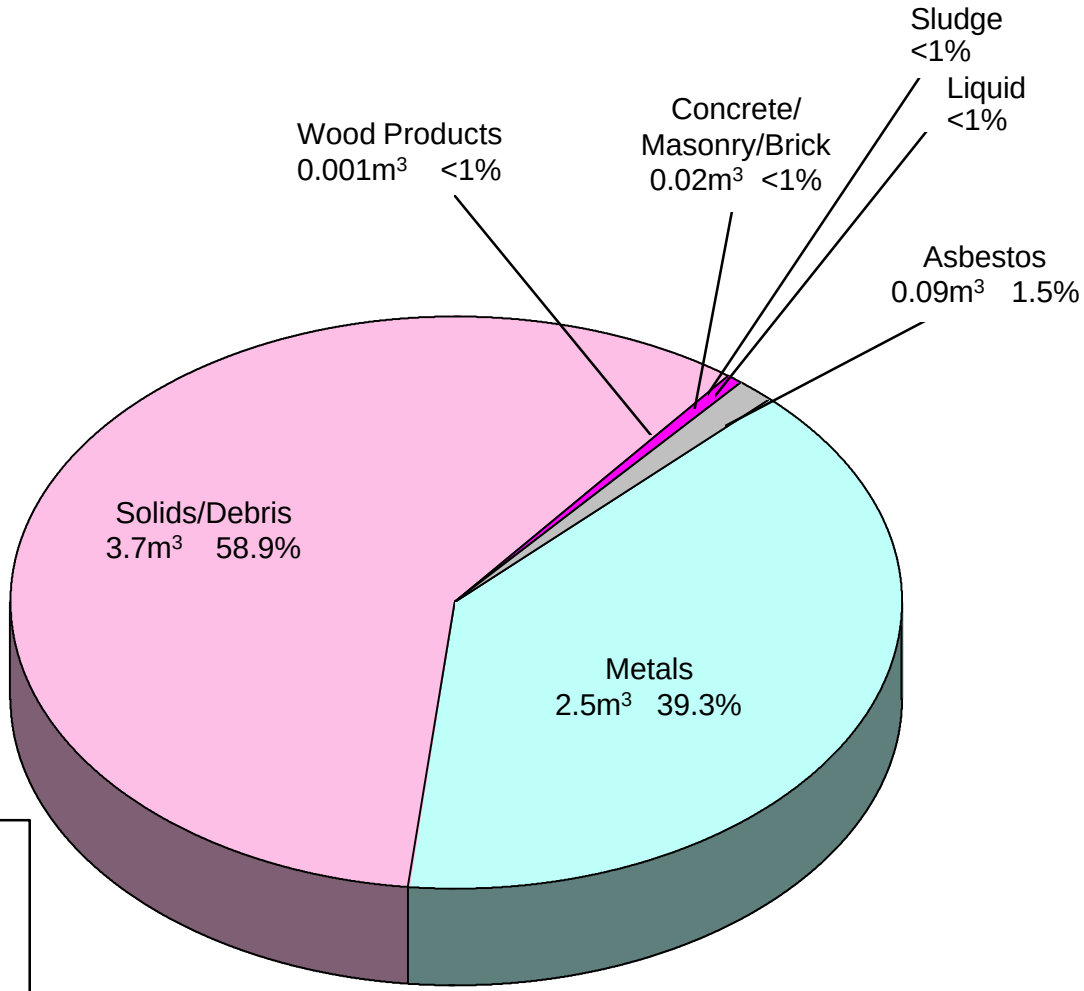
RADIOACTIVE CONTAMINATION ACCOUNTS FOR OVER HALF OF THE PROBLEMS SETS BY VOLUME, WITH SANITARY AND MIXED LOW LEVEL WASTE ACCOUNTING FOR A SIGNIFICANT PORTION OF THE TOTAL VOLUME



Total Problem Set Volume of Contaminated Media: 6.3 Million m³

Source: EM-40 Core Database, July 30, 1996
Note: Unspecified contaminants have no reported volumes

SOLID/DEBRIS AND METALS DOMINATE OTHER MEDIA IN THE PROBLEM SETS



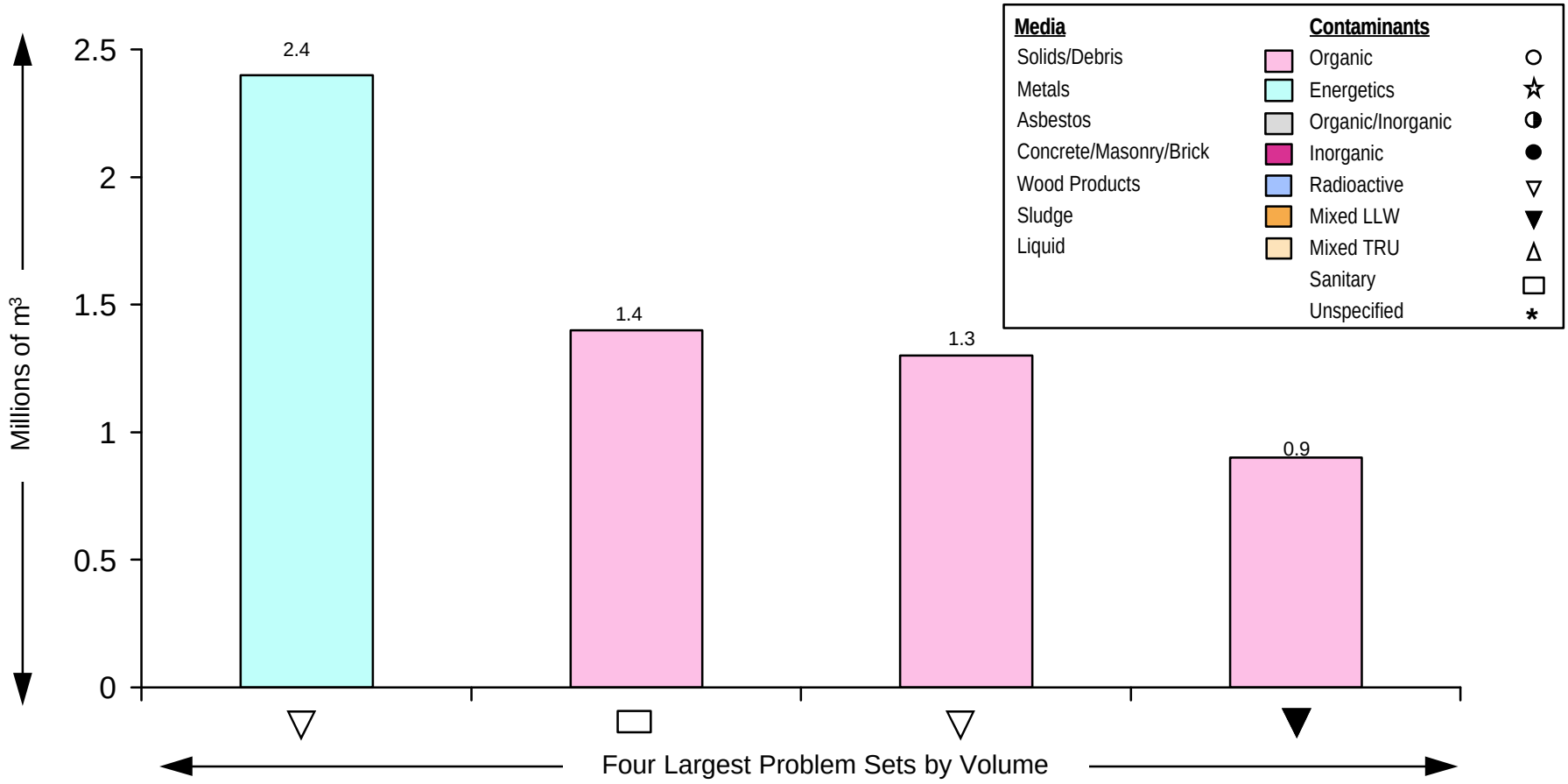
Total Problem Set Volume of Contaminated Media: 6.3 Million m^3

Contaminated Media by Volume (Million Cubic Meters)

Source: EM-40 Core Database, July 30, 1996

METALS AND SOLIDS/DEBRIS DOMINATE THE PROBLEM SETS AS MEASURED BY VOLUME OF CONTAMINATED MEDIA

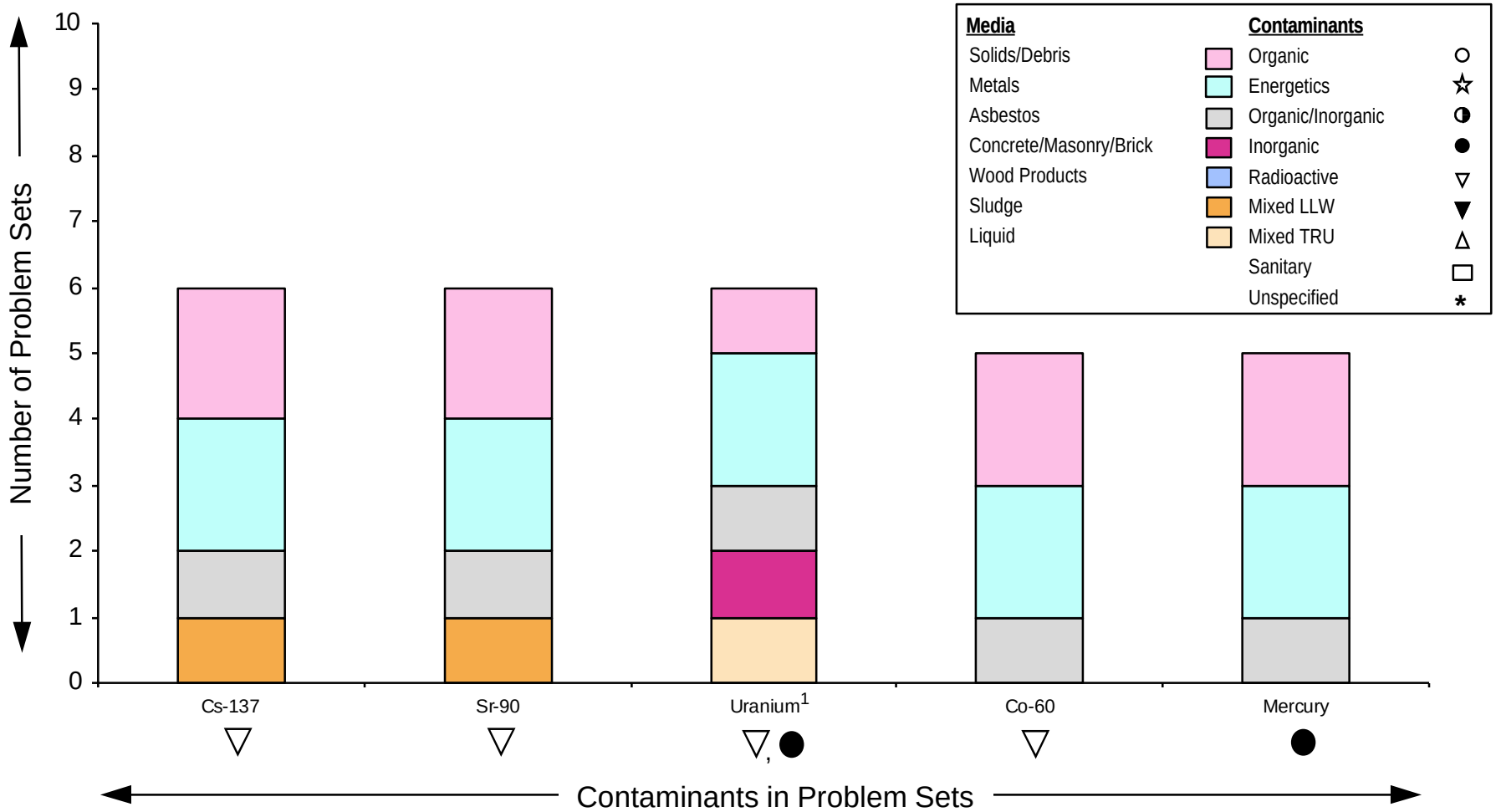
- Total volume in 23 problem sets: 6.3 million m^3.
- Four problem sets account for 97% of the volume (6.1 million m^3).



Source: EM-40 Core Database, July 30, 1996

ALL OF THE TOP SIX CONTAMINANTS ARE RADIOACTIVE OR INORGANIC

- The distribution of contaminants is based on the incidence of contaminants within and among the 23 problem sets, not on the concentration or the extent of the contamination.



[1] Uranium was reported as both radioactive and inorganic contamination

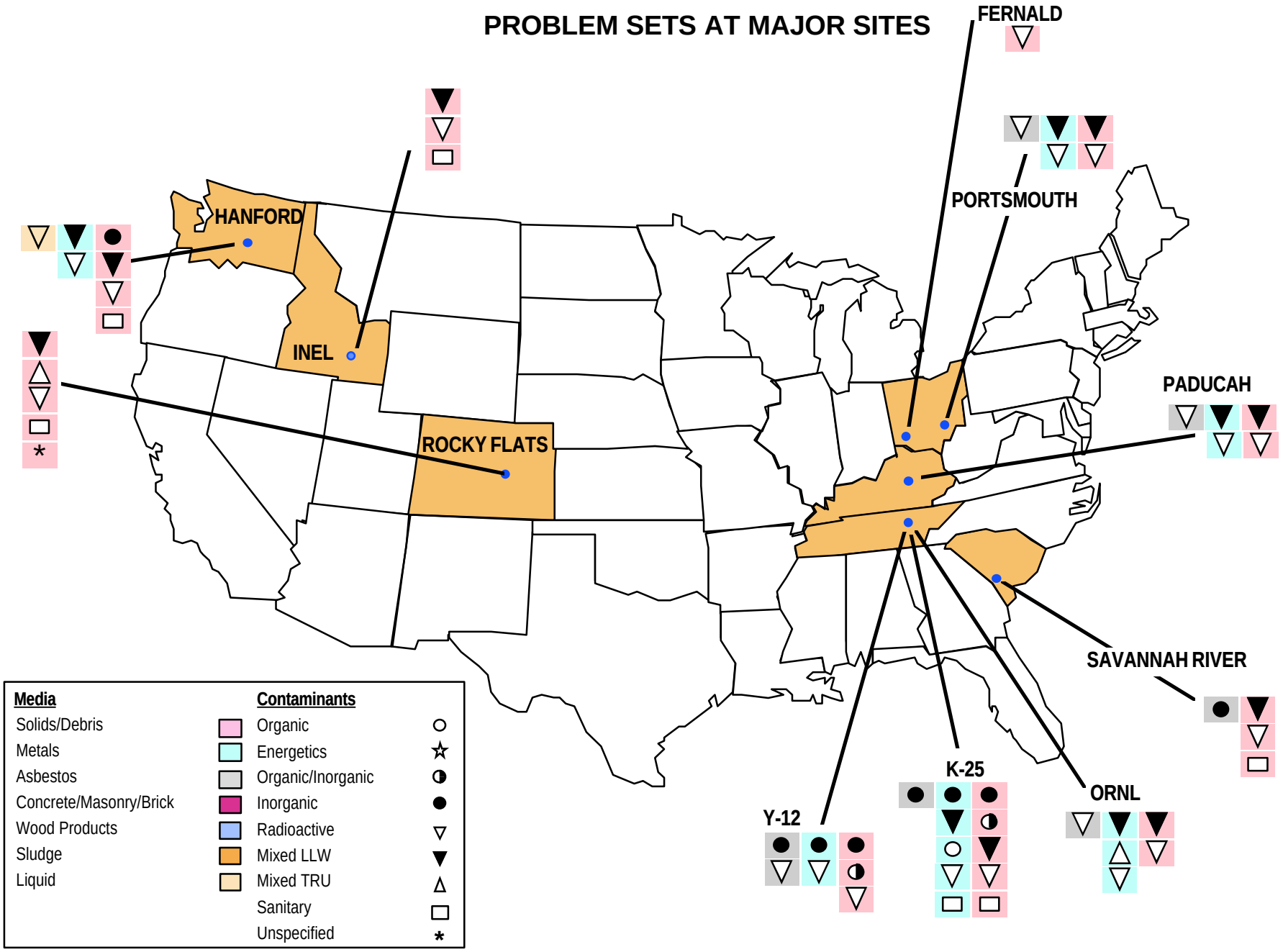
Source: EM-40 Core Database, July 30, 1996

THE TOP PROBLEM SETS BY VOLUME REPRESENT A SIGNIFICANT NUMBER OF GEOGRAPHIC SITES, CRLs, AND FACILITIES

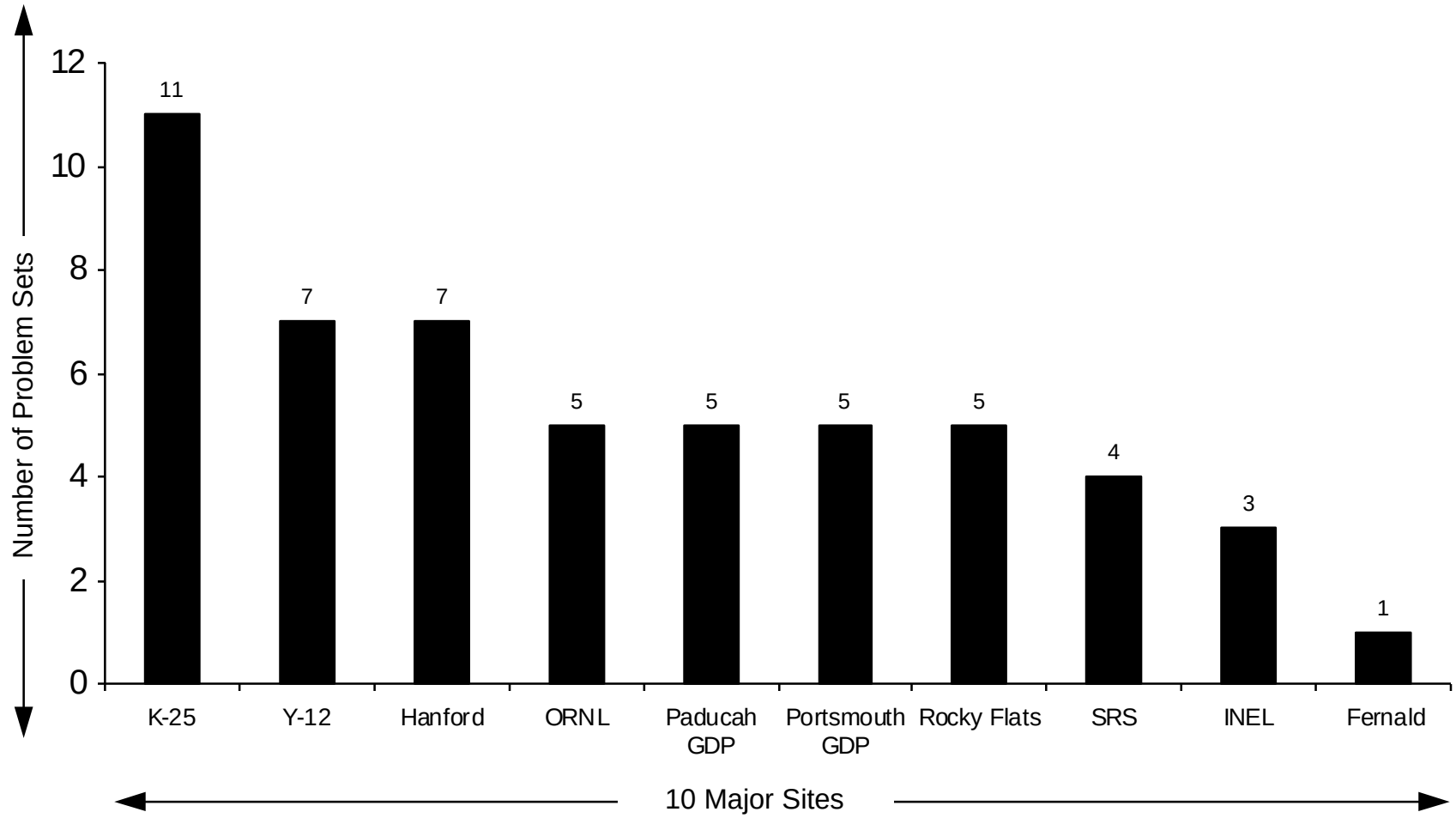
Problem Set	Volume (Millions m^3)	#Geographic Sites[1]	#CRLs[2]	#Facilities[3]
Metals: Radioactive	2.4	17	65	565
Solids/Debris: Sanitary	1.4	11	130	488
Solid/Debris: Radioactive	1.3	26	135	915
Solids/Debris: Mixed LLW	0.9	8	83	442

[1] Total number of geographic sites for all Decommissioning Requirements Definition problem sets: 36
[2] Total number of CRLs with Decommissioning Requirements Definition problem sets: 217
[3] Total number of facilities associated with Decommissioning Requirements Definition problem sets: 949

PROBLEM SETS AT MAJOR SITES



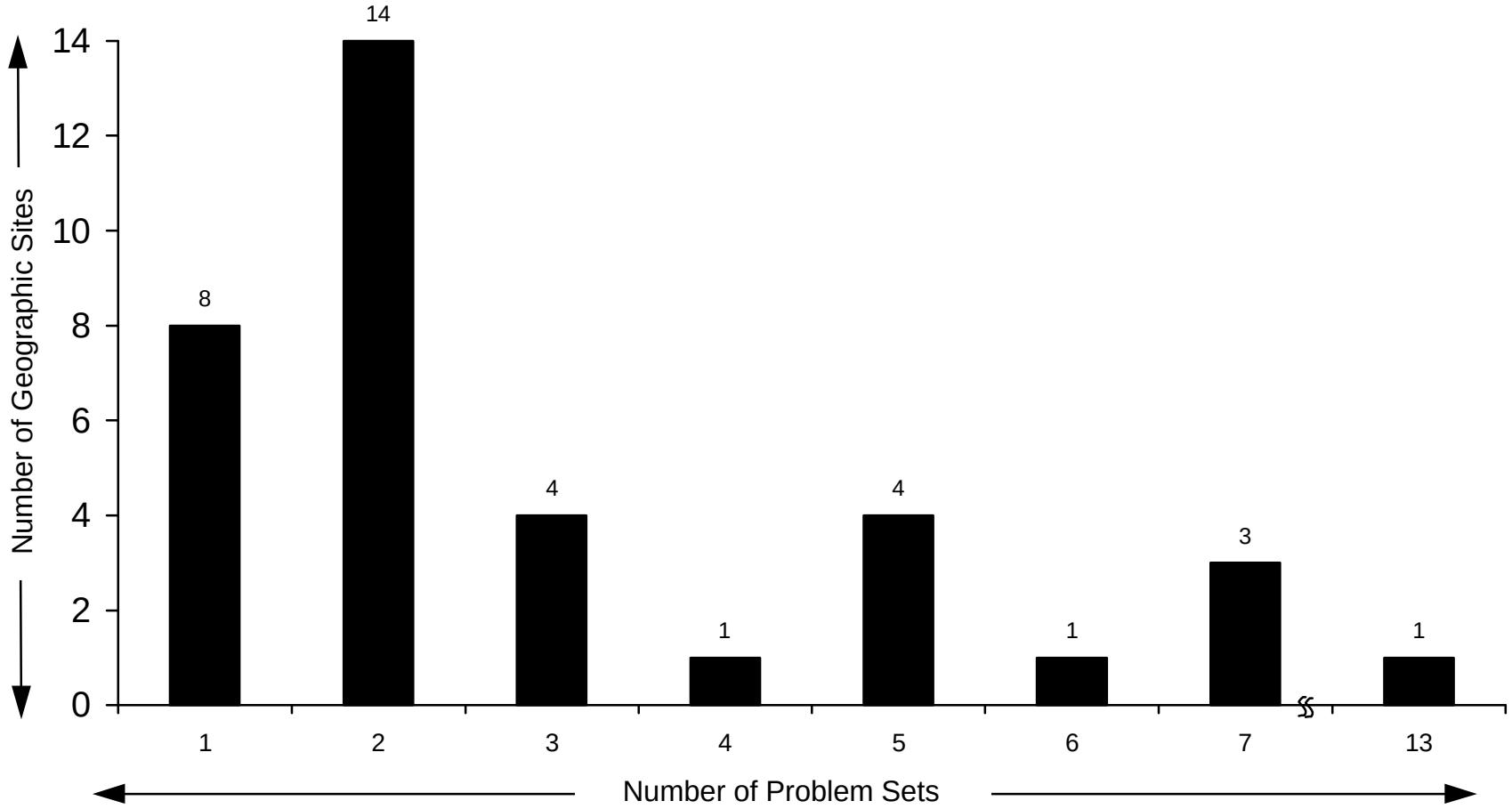
SEVEN OF THE 10 MAJOR SITES HAVE FIVE OR MORE PROBLEM SETS



Note: Y-12, ORNL, and K-25 (along with Oak Ridge Reservation) are counted as one site, Oak Ridge, in the remaining geographic site graphs

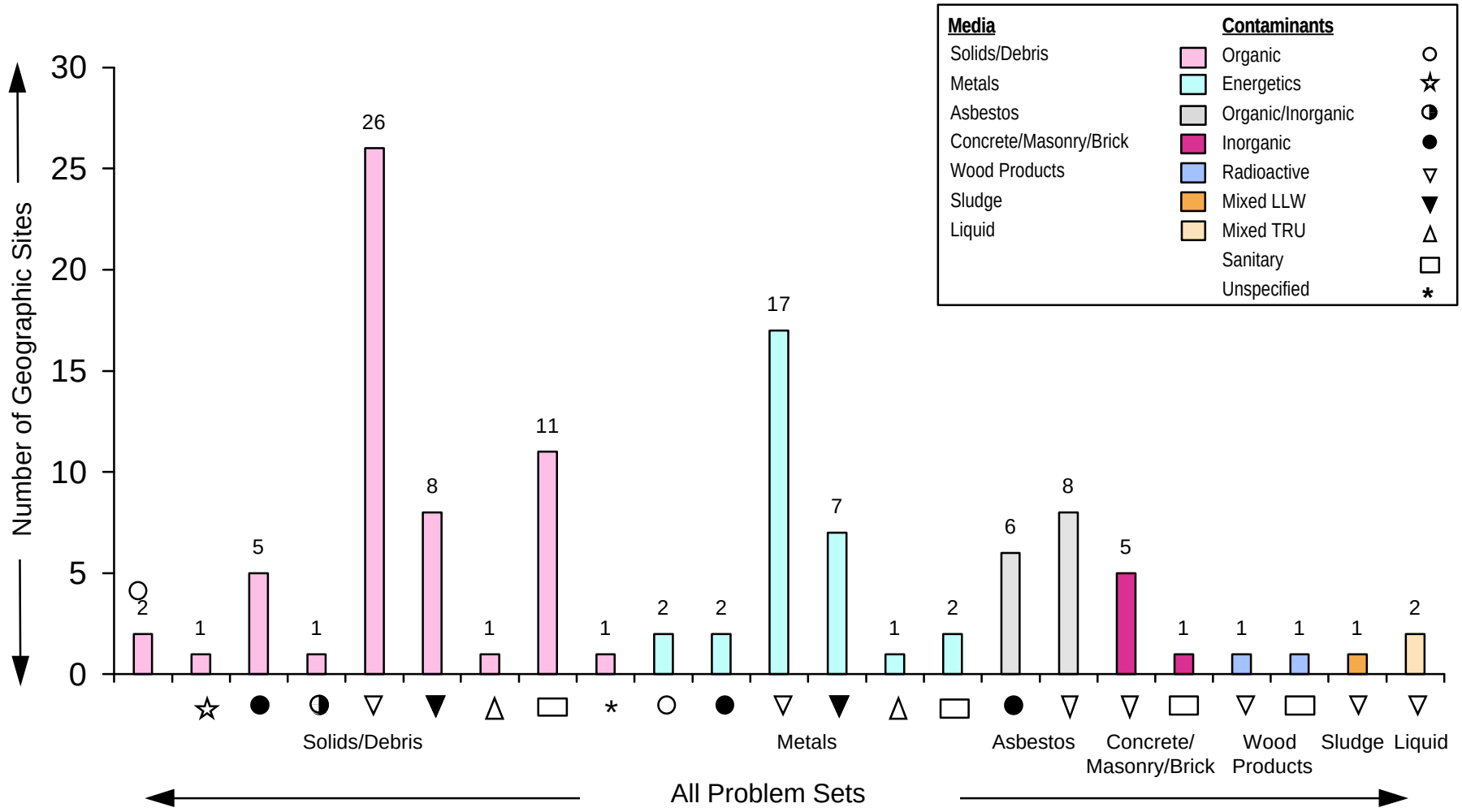
Source: EM-40 Core Database, July 30, 1996

THE MAJORITY OF GEOGRAPHIC SITES REPORTING DECOMMISSIONING PROBLEM SETS HAVE TWO OR FEWER



Source: EM-40 Core Database, July 30, 1996

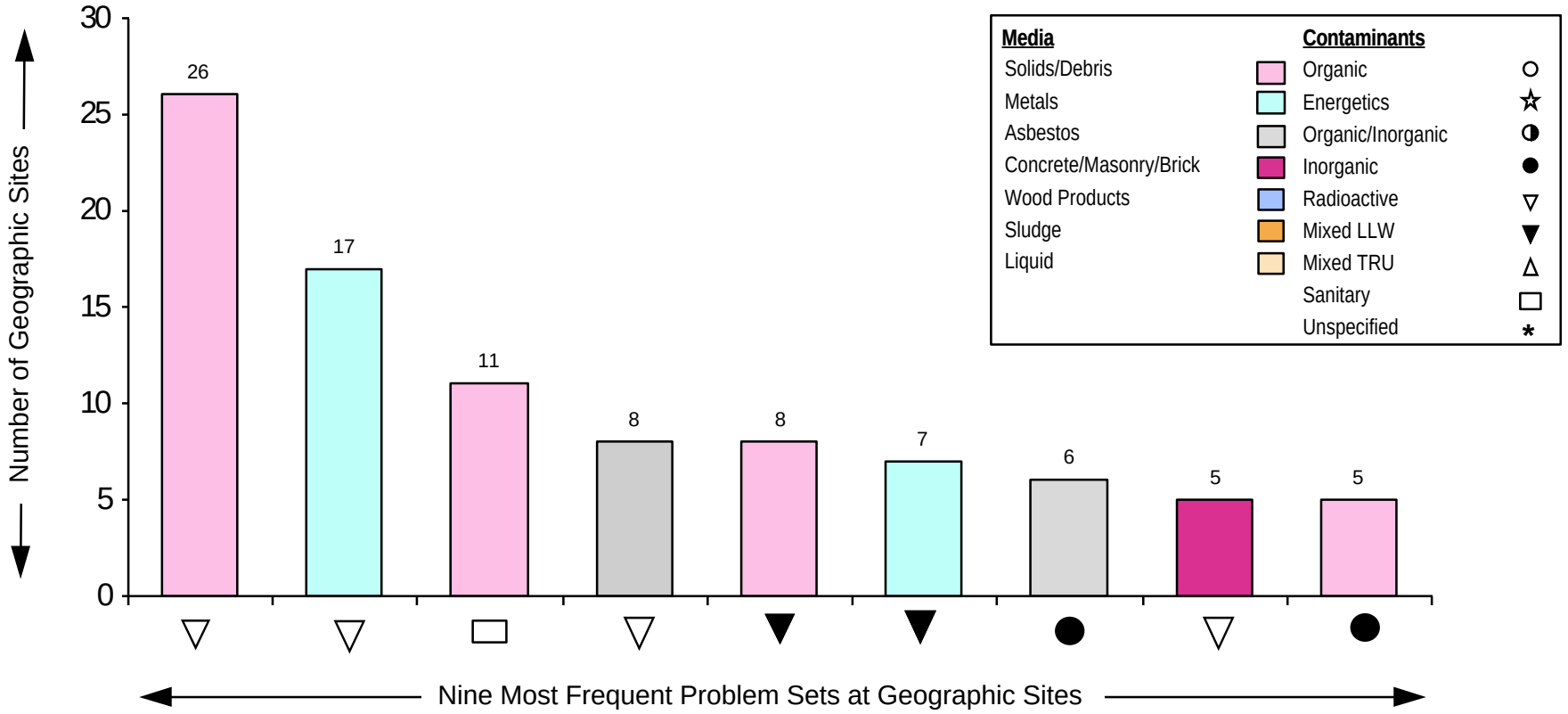
DISTRIBUTION OF PROBLEM SETS AT GEOGRAPHIC SITES



Source: EM-40 Core Database, July 30, 1996

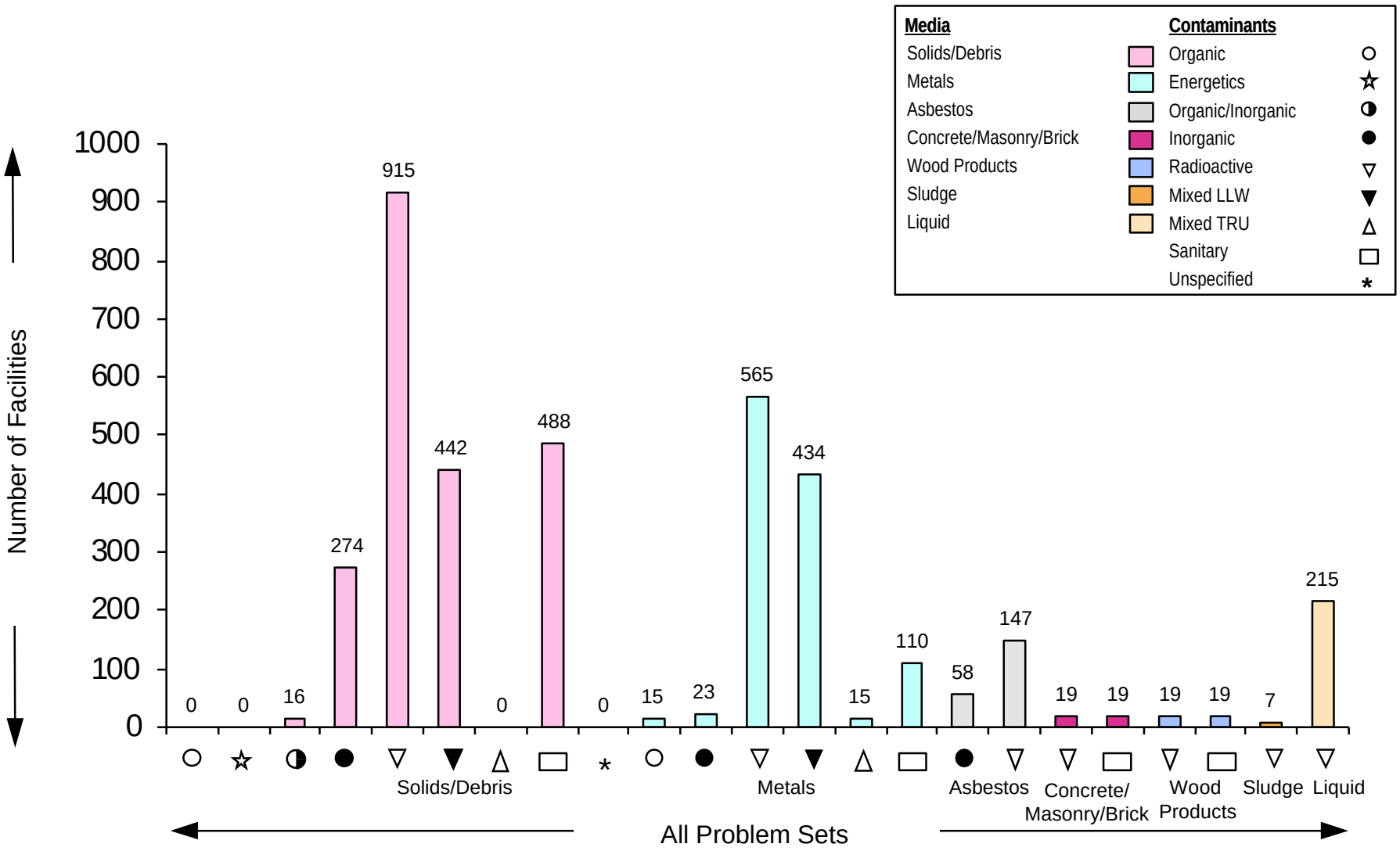
THE DISTRIBUTION OF PROBLEM SETS BY GEOGRAPHIC SITES IS WEIGHTED TOWARD RADIOACTIVE, INCLUDING MLLW, CONTAMINATION, ESPECIALLY IN SOLIDS/DEBRIS AND METALS

- 132 geographic sites in Environmental Restoration Program.
- 36 geographic sites have one or more decommissioning problem sets.



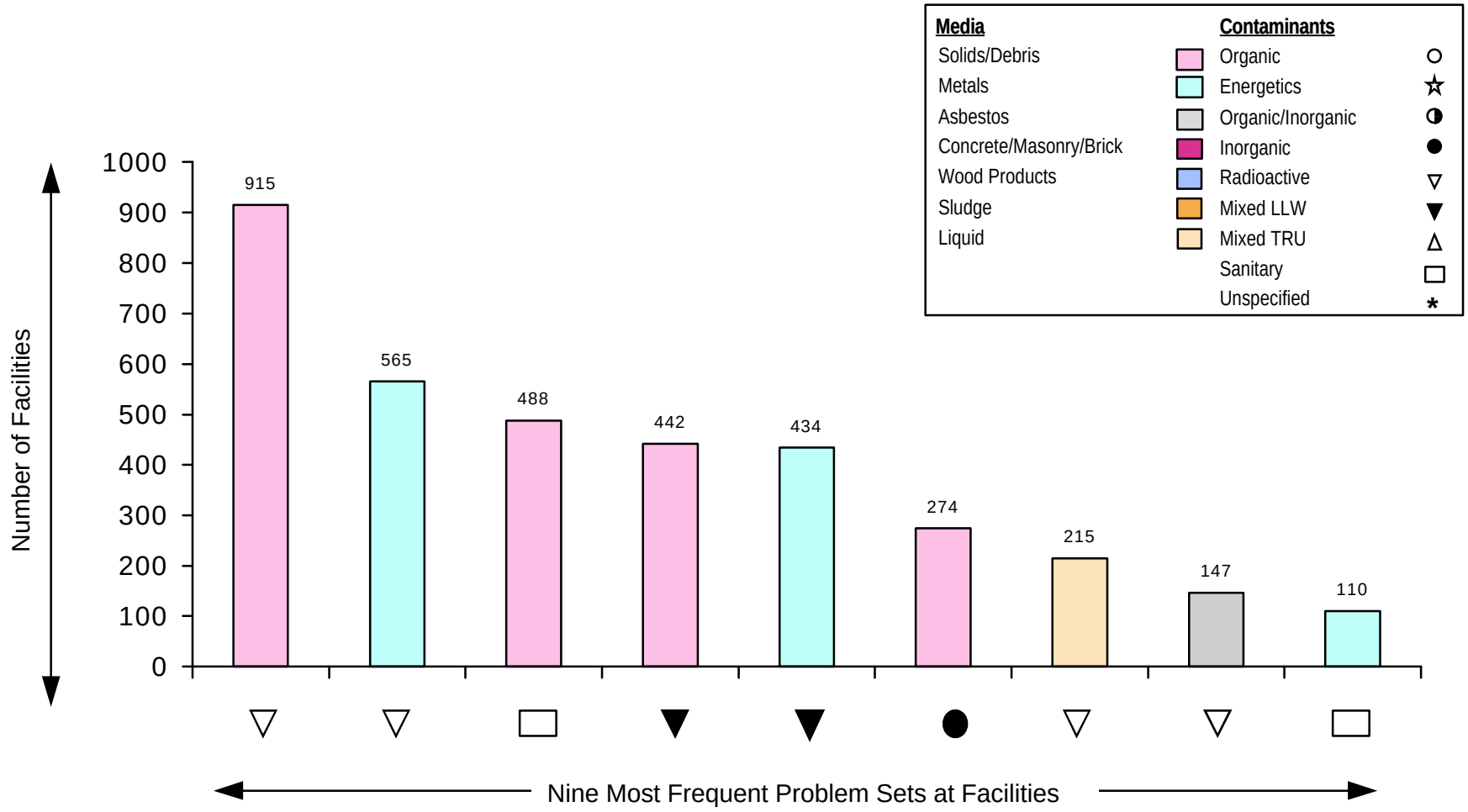
Source: EM-40 Core Database, July 30, 1996

PROBLEM SET DISTRIBUTION AT FACILITIES



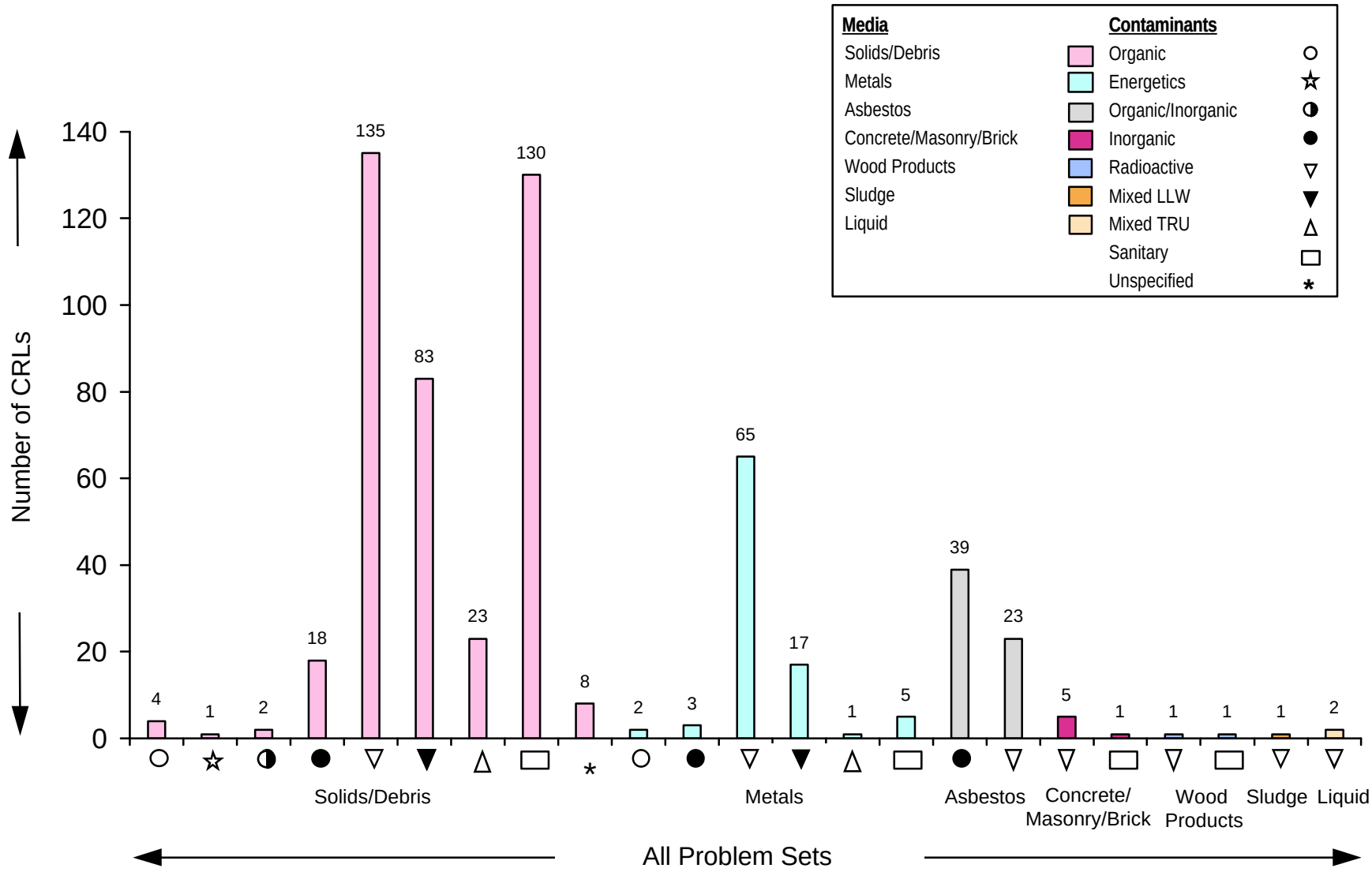
Source: EM-40 Core Database, July 30, 1996

MUCH LIKE THE GEOGRAPHIC DISTRIBUTION, SOLIDS/DEBRIS AND METALS WITH RADIOACTIVE, INCLUDING MLLW, CONTAMINATION DOMINATES THE FACILITY DISTRIBUTION



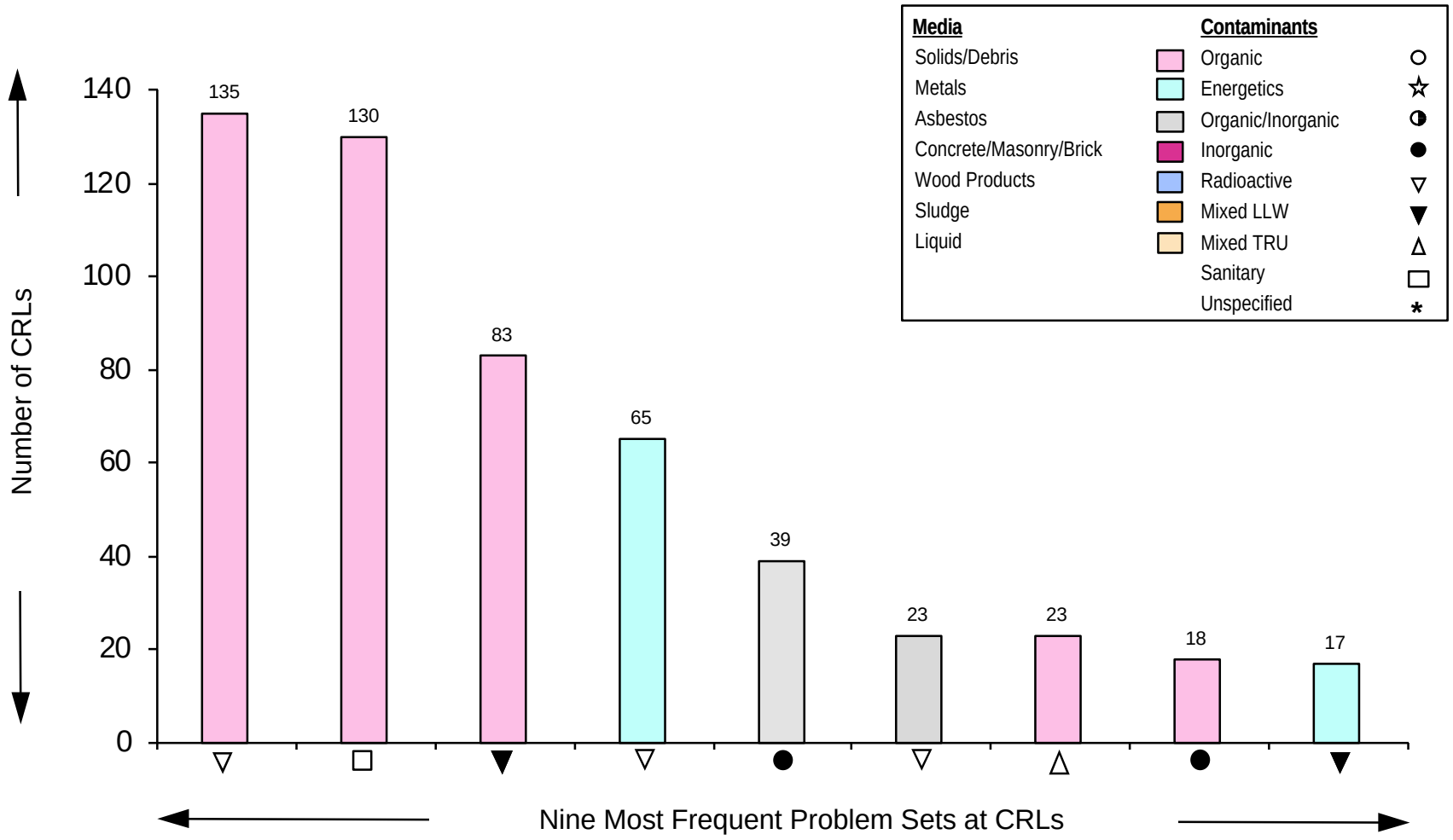
Source: EM-40 Core Database, July 30, 1996

PROBLEM SET DISTRIBUTION AT THE CRL



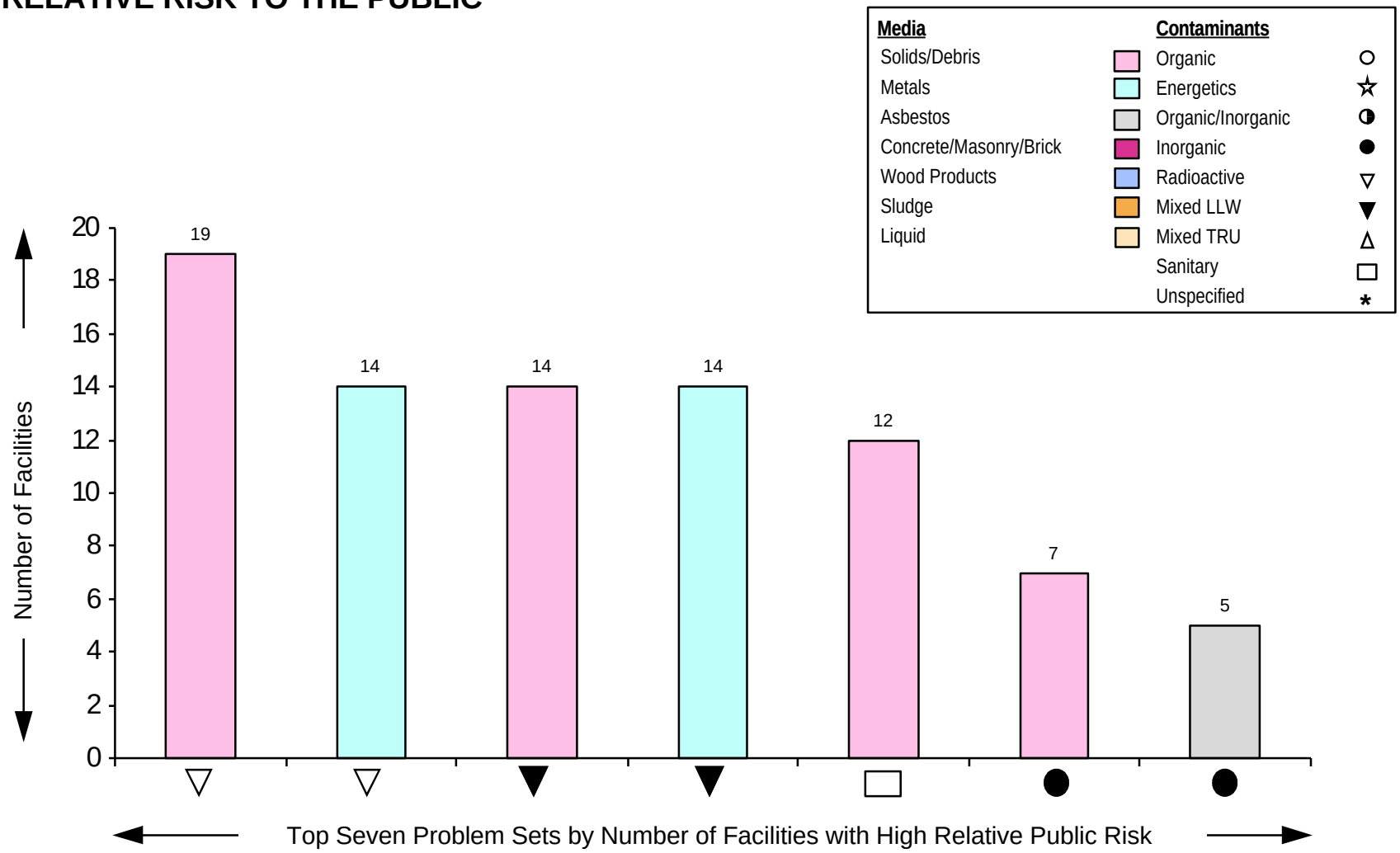
Source: EM-40 Core Database, July 30, 1996

THE DISTRIBUTION OF PROBLEM SETS AT THE CORE DATABASE REPORTING LEVEL (CRL) SHOWS DOMINANCE OF SOLIDS AND DEBRIS



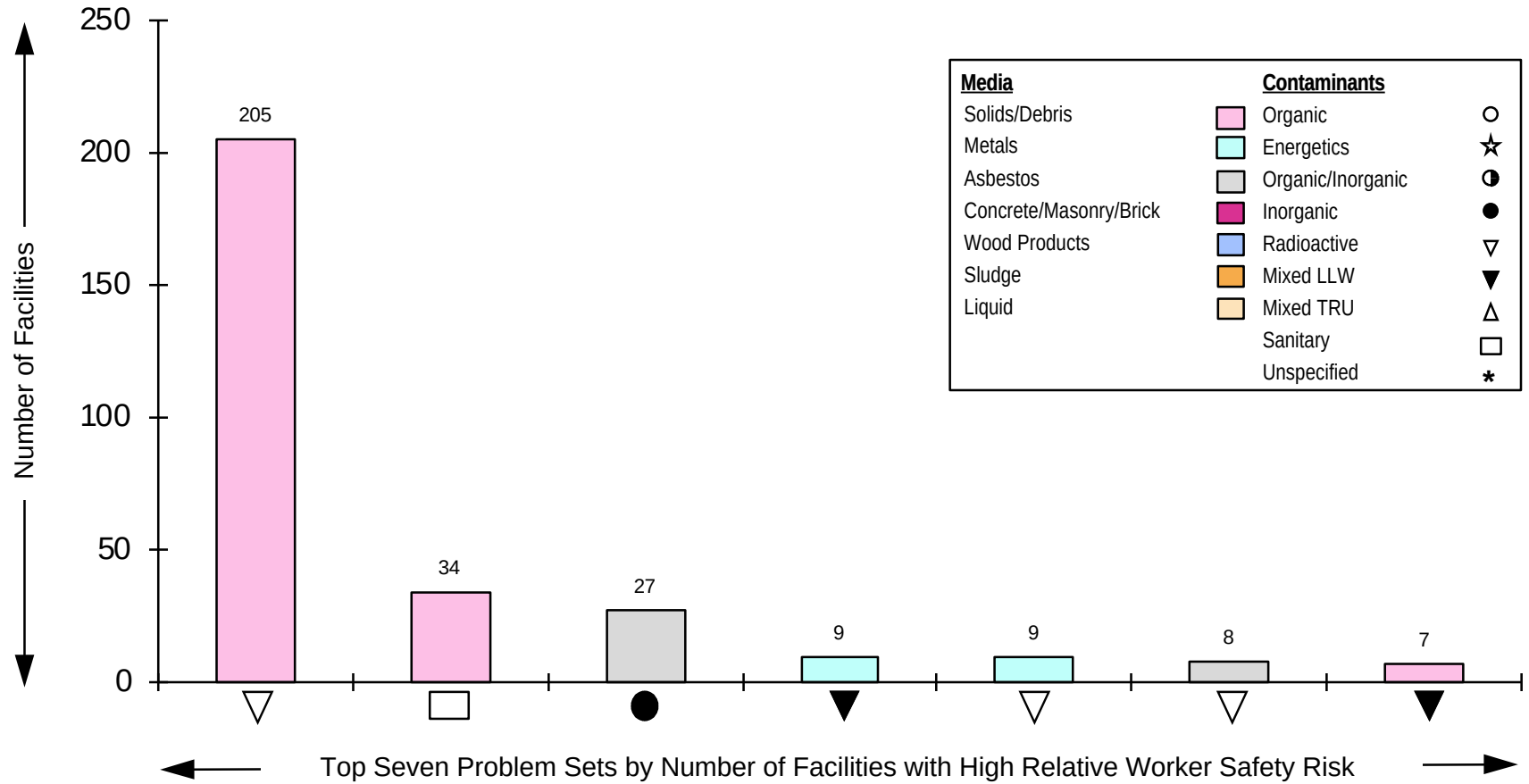
Source: EM-40 Core Database, July 30, 1996

SOLIDS/DEBRIS AND METALS DOMINATE THE DISTRIBUTION OF FACILITIES WITH HIGH RELATIVE RISK TO THE PUBLIC



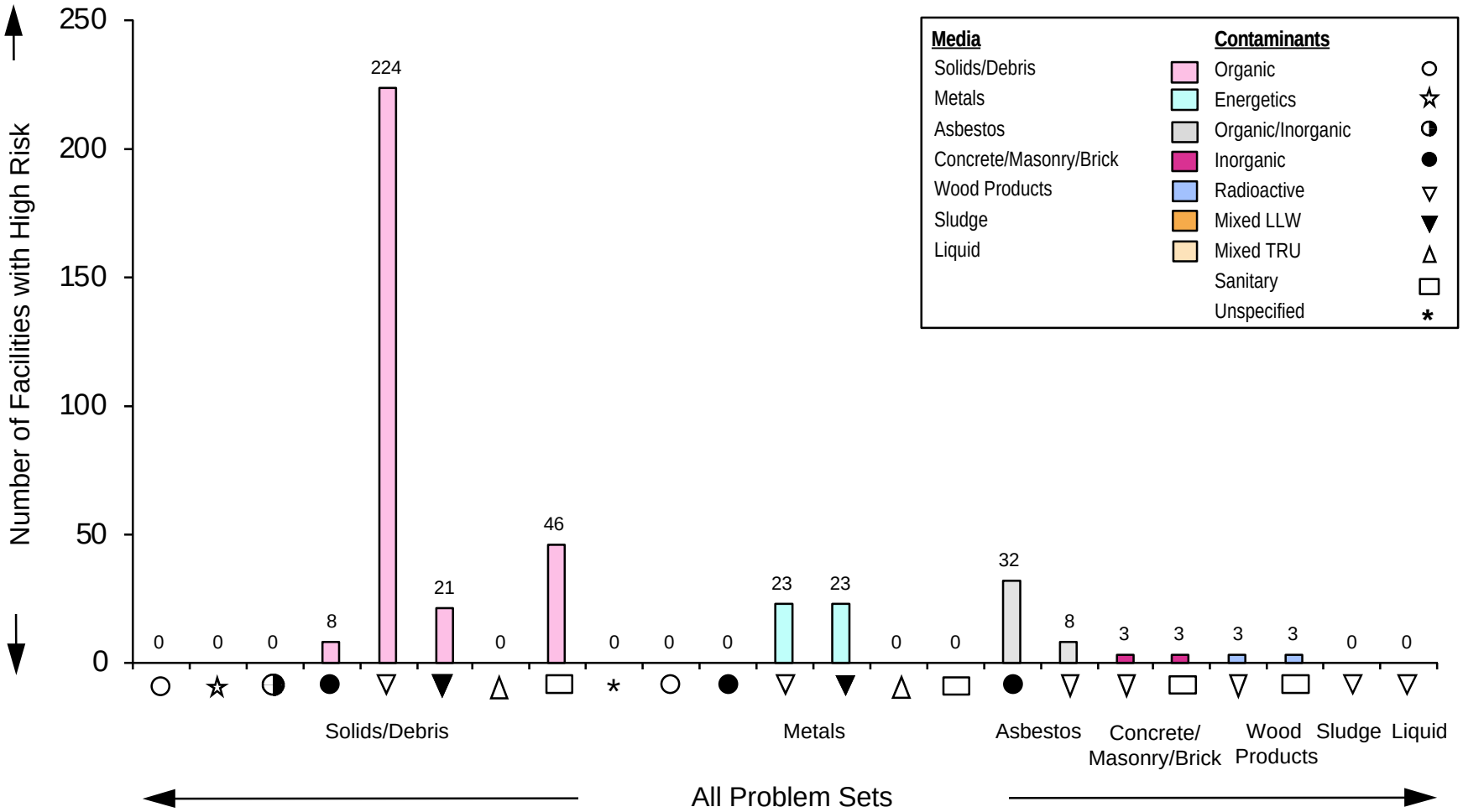
Source: EM-40 Core Database, July 30, 1996

INCIDENCE OF FACILITIES WITH HIGH RELATIVE RISK FOR WORKER SAFETY IS SIGNIFICANTLY HIGHER THAN PUBLIC RISK



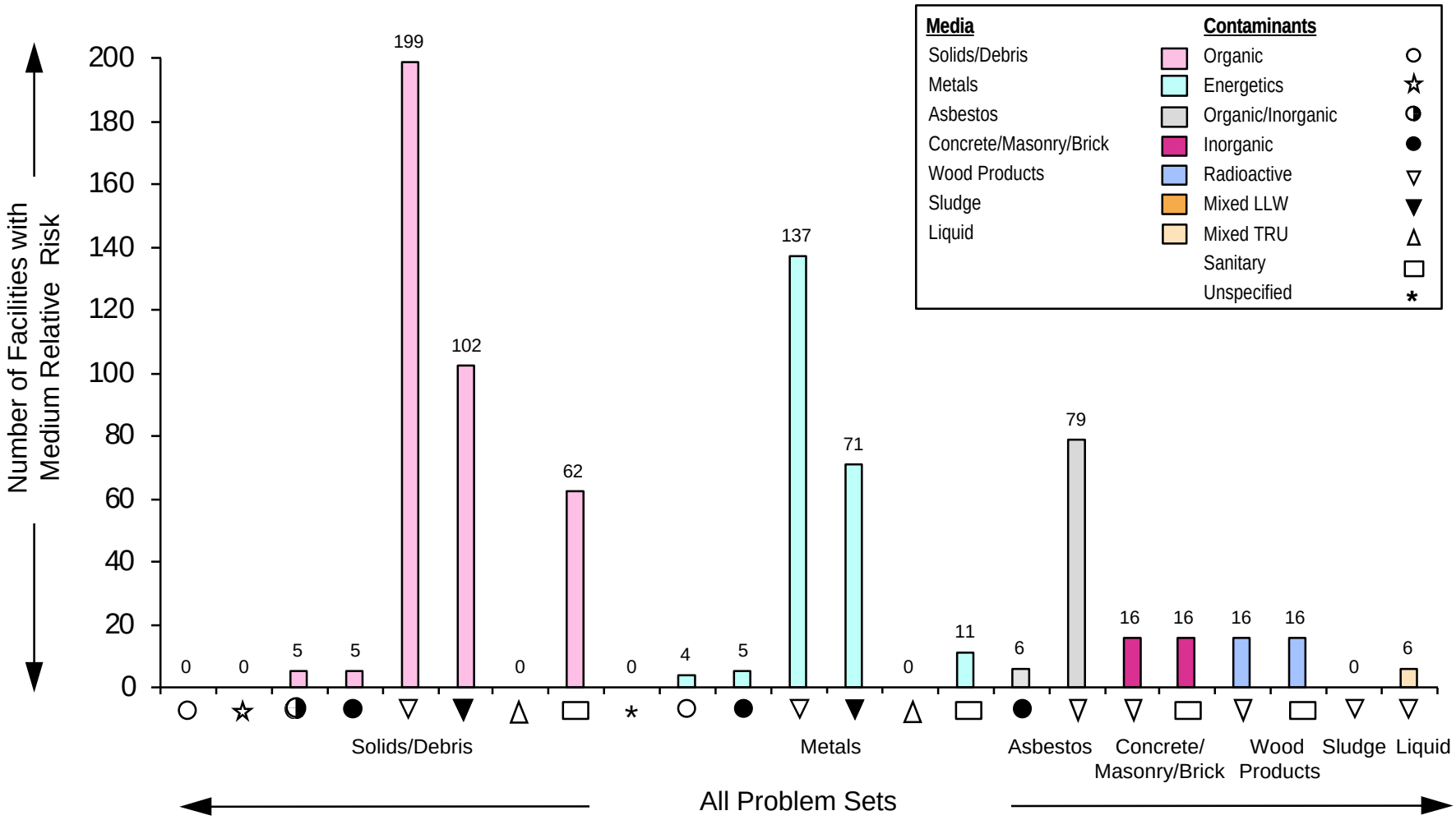
Source: EM-40 Core Database, July 30, 1996

FACILITIES REPORTING THE GREATEST INCIDENCE OF HIGH RELATIVE RISK ARE ASSOCIATED WITH RADIOACTIVELY CONTAMINATED SOLIDS/DEBRIS



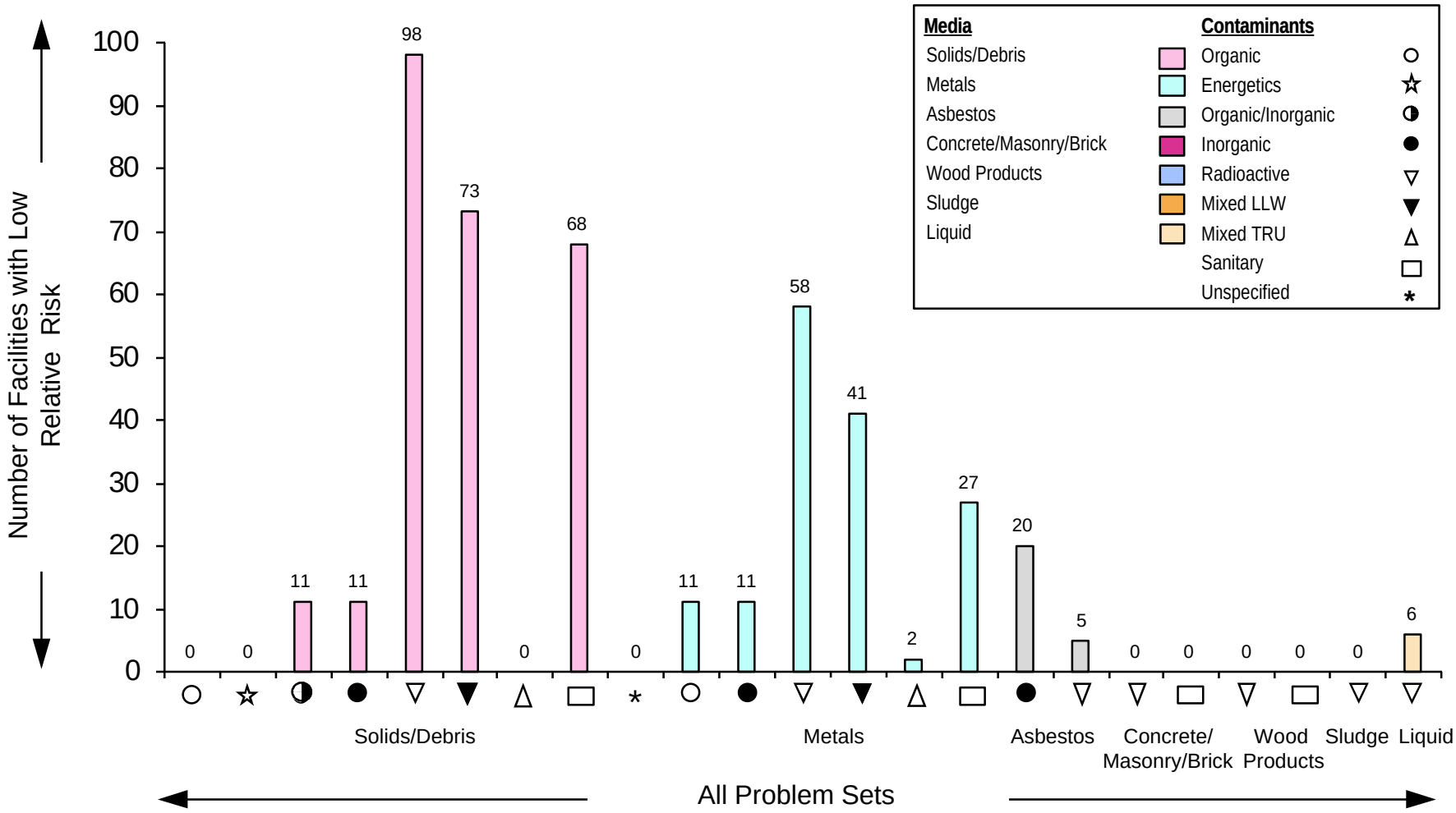
Source: EM-40 Core Database, July 30, 1996

THE MAJORITY OF MEDIUM RELATIVE RISK AT FACILITIES IS ASSOCIATED WITH RADIOACTIVE AND MIXED LLW CONTAMINATION



Source: EM-40 Core Database, July 30, 1996

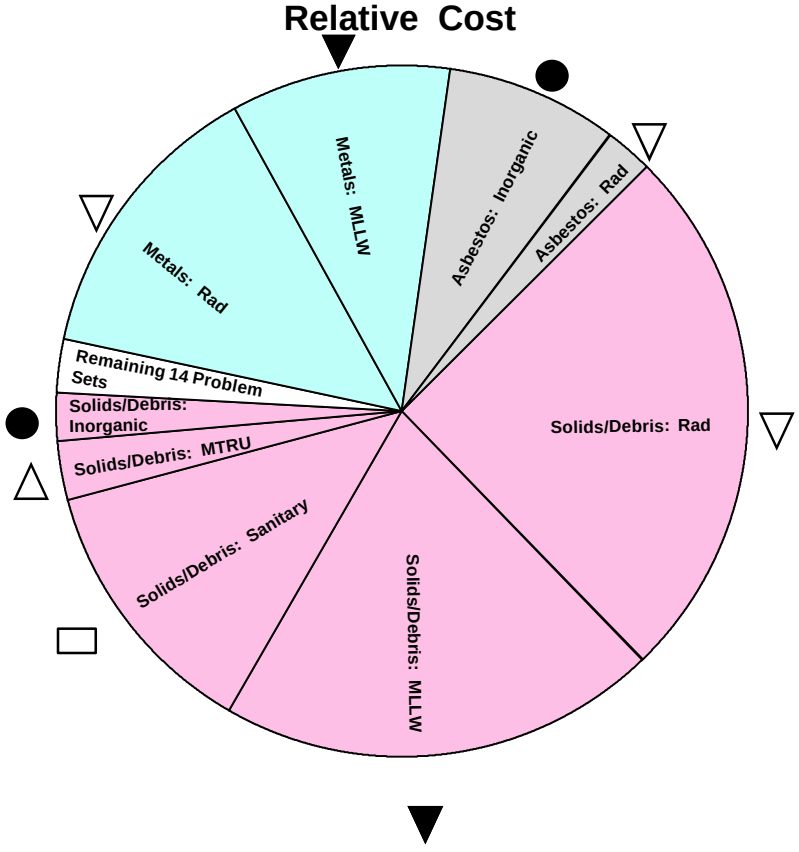
THE DISTRIBUTION OF FACILITIES WITH LOW RELATIVE RISK ALSO IS WEIGHTED TOWARD RADIOACTIVE, MIXED LLW, AND SANITARY CONTAMINANTS



Source: EM-40 Core Database, July 30, 1996

WITHIN THE LIMITATIONS OF THE DATA, NINE PROBLEM SETS APPEAR TO ACCOUNT FOR THE MAJORITY OF COSTS, WHILE COSTS FOR THE REMAINING 14 PROBLEM SETS APPEAR RELATIVELY SMALL

- Based on the 1996 Baseline Environmental Management Report (BEMR) projections, about $20.8 billion will be required for decommissioning, so cost could be a consideration in identifying high priority problem sets.
- The Core Database contains 217 CRLs that are associated with the 23 decommissioning problem sets.
- The Core Database contains 60 instances of CRLs comprising a single problem set, which permits a direct link between CRL cost and a problem set; remaining CRL/cost relationships cannot be directly linked.
- Without a direct link between problem sets and costs, cost impacts cannot be estimated reliably, and given the variability in the relationships among problem sets and costs, attempts to aggregate or compare the available cost data could produce misleading results.
- Within the limitations of the data, solids/debris problem sets account for over half the relative costs.



COMPARISON OF THE PROBLEM SETS ACROSS THE DIFFERENT DIMENSIONS SHOWS THAT EIGHT PROBLEM SETS PREDOMINATE CONSISTENTLY

- Problem sets are arranged in the table according to their rank across and within all of the dimensions.
- Four problem sets in total account for the top three problem sets in six of the seven dimensions.
- Solids/debris and metals contamination predominates in all problem sets.
- Radioactive contaminants, including mixed LLW, are the most widely represented contaminants in the problem sets.

Problem Set	Rank Within Dimension						
	Volume	Geo. Site Dist.	Facility Dist.	CRL Dist.	Relative Risk Dist. PS	Relative Risk Dist. WKR	Relative Cost
Solids/Debris - Radioactive	3	1	1	1	1	1	1
Metals - Radioactive	1	2	2	4	2 [1]	4 [1]	3
Solids/Debris - Sanitary	2	3	3	2	5	2	4
Solids/Debris - Mixed LLW	4	4 [1]	4	3	2 [1]	7	2
Metals - Mixed LLW	6	6	5	9	2 [1]	4 [1]	5
Asbestos - Inorganic	5	7	-	5	7	3	6
Asbestos - Radioactive	9	4 [1]	8	6	-	6	8
Solids/Debris - Inorganic	8	8	6	8	6	-	9

PS = public safety and WKR = worker safety
"-" means below top five problem sets in that dimension
[1] Denotes a tie

Ranking: 1 → 9
highest lowest

THE SHORT ANSWER

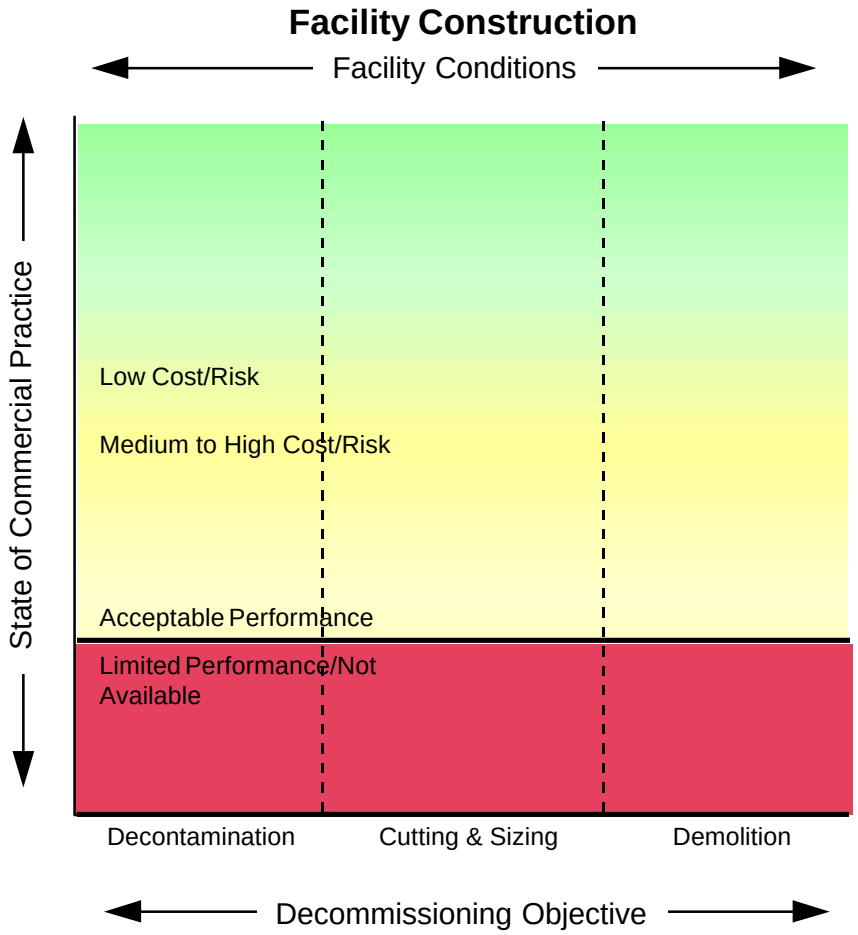
INTRODUCTION

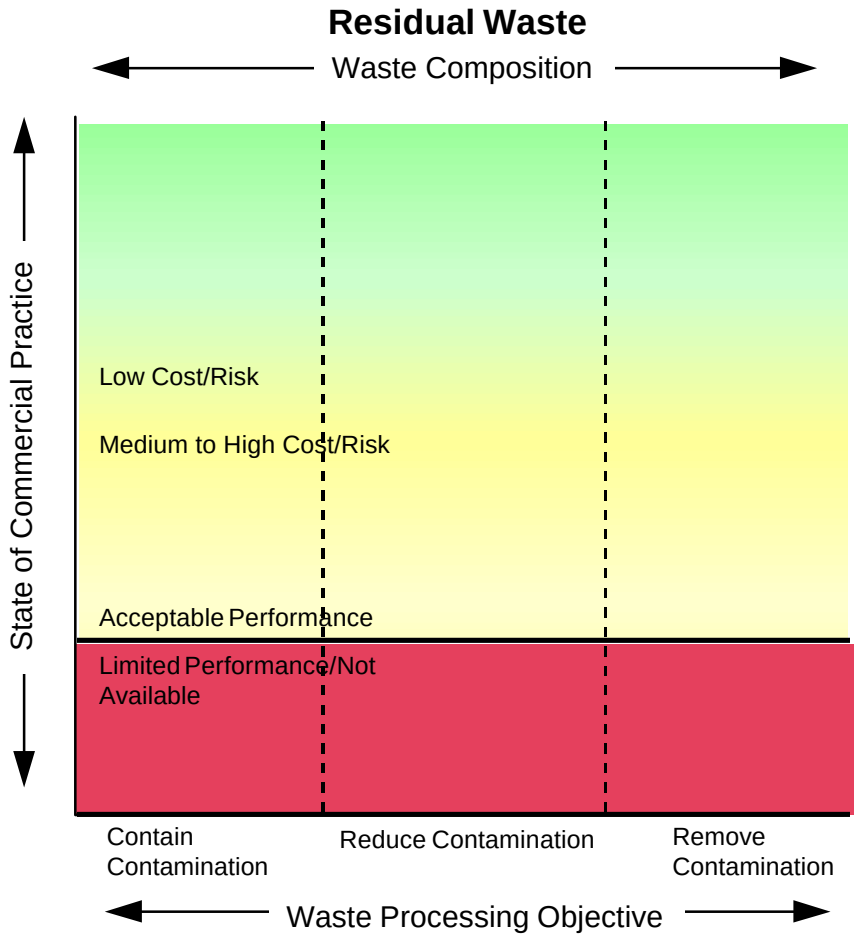
PROBLEM SET DEFINITION

TECHNOLOGY SCREENING ANALYSIS

NEXT STEPS

- Facility conditions and waste composition are a set of conditions that affect technology performance and selection (e.g., presence of mercury, size of piping).
- Facility conditions in the PAM were derived from the Decommissioning Benchmarking Final Report, January 15, 1997; the Decommissioning Benchmarking is discussed briefly in the Introduction of this report.
- Assumptions and limitations regarding the conditions are detailed in the Introduction and Technology Screening Analysis sections of this report.





CLEANUP OBJECTIVES AND THE STATE OF COMMERCIAL PRACTICE DETERMINE HOW WELL A GIVEN TECHNOLOGY SATISFIES THE ENVIRONMENTAL CONDITIONS ASSOCIATED WITH PROBLEM SETS

- The Environmental Restoration Program needs information about commercial practice in order to:
  - Identify and articulate technology requirements for completing site restoration.
  - Identify where performance-based contracting can keep cleanup costs down.
  - Identify problem sets where policy and/or regulatory issues impede performance.

- This framework depicts the analytic model used to assess commercially-available technologies identified in the Preferred Alternatives Matrix (PAM) with respect to Environmental Restoration problem sets.

- The shaded areas of the figure represent the state of commercial practice, given the cleanup objective and environmental conditions associated with problem sets.

- The green-yellow area indicates the availability of low cost/risk technologies that satisfy a given problem set, with declining degrees of acceptability as the technology cost and/or risk rises.

- The shift from yellow to red marks the “bright line” between marginal performance and the complete absence of an acceptable solution.

- The model also highlights areas where performance-based contracting is effective and desirable, with the green range presenting clear-cut opportunities for cost and performance improvements and the yellow range offering more modest prospects.

PREFERRED ALTERNATIVES MATRIX TECHNOLOGY RANKING CRITERIA

Rank	Title	Criteria
●	Preferred alternative	Technology is commercially available in this application. Lowest cost, best performance, and low risk.
◕	Probable alternative	Technology is commercially available in this application. Low cost, good performance, and low risk.
◑	Potential alternative	Technology is commercially available in this application. Acceptable performance, but medium cost and/or medium risk.
◔	Possible alternative	Technology is commercially available. High cost or high risk (e.g., not proven in this application).
○	Unlikely	Technology is commercially available. Limited performance or high cost or high risk.
⊗	Not applicable	

Best

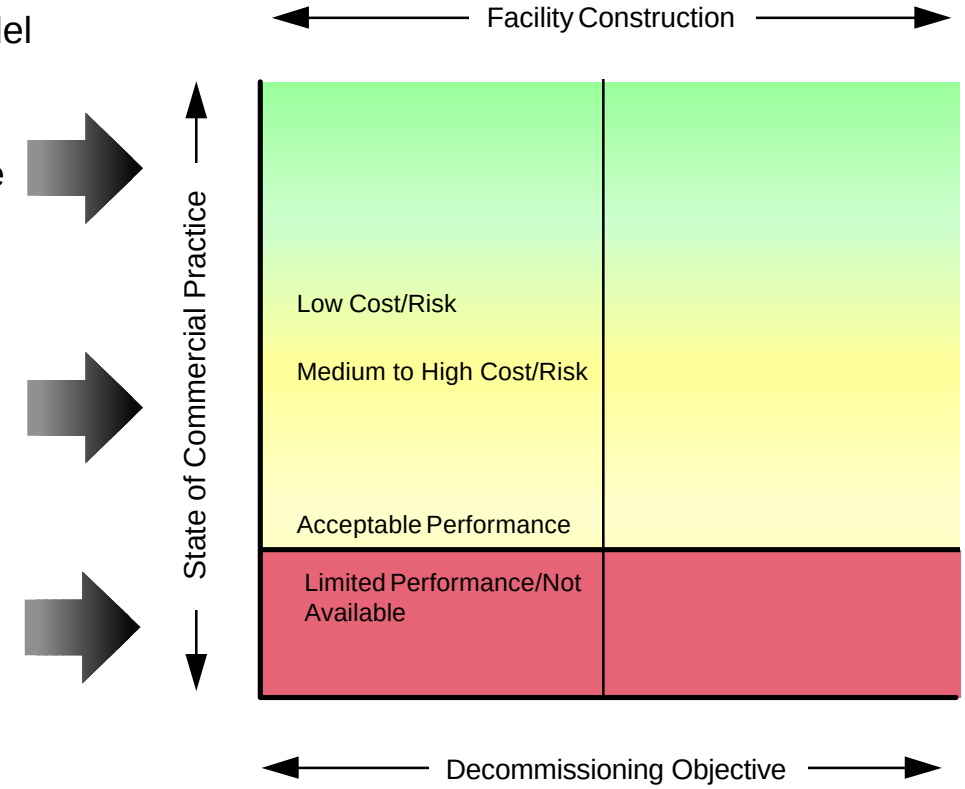
Cost
Risk
Performance

Worst

PAM SCORES PROVIDE AN INITIAL BASIS FOR MAPPING COMMERCIALLY-AVAILABLE TECHNOLOGIES TO PROBLEM SETS

- The PAMs subjectively rank commercially available technologies on the basis of performance, cost, and risk; the PAMs will become more objective as cost and performance reports are developed and the results incorporated into the PAMs.

- The PAM scores were mapped to the model as follows:
  - Green: More than one preferred or probable alternative[1]
  - Yellow: Only one preferred or probable alternative or more than one potential or possible alternative[1]
  - Red: Only one potential or possible alternative or only unlikely or not applicable alternatives



[1] Analysis of disposal did not include the "more than one" criteria; for example, if only one preferred or probable alternative is available, disposal would map to green.

THE MODEL ALLOWS HIGH-LEVEL CONCLUSIONS TO BE DRAWN BY AGGREGATING RESULTS INTO PIE CHARTS

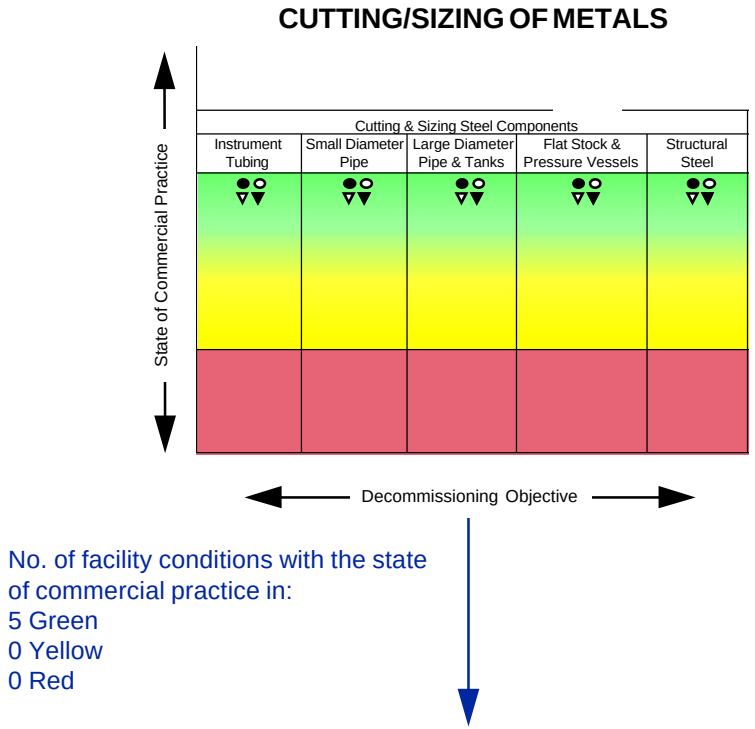
- Decontamination, cutting and sizing, demolition, and ex situ treatment can be compared across problem sets of same media by evaluating the analytical model.

- As seen in the example methodology diagram, the results for cutting and sizing of metals (5 green) are aggregated to form a summary pie chart (100% green).

- In this fashion, it can be concluded that cutting and sizing of metals is satisfied by commercial practice and there are numerous opportunities for performance-based contracting.

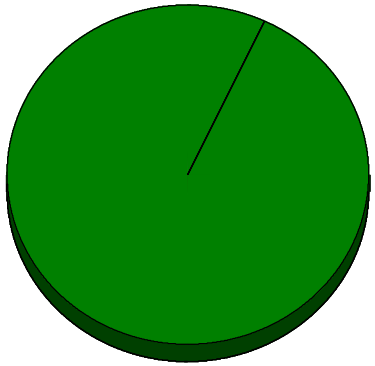
METHODOLOGY FOR TECHNOLOGY ANALYSIS

Example: Cutting and Sizing of Metals

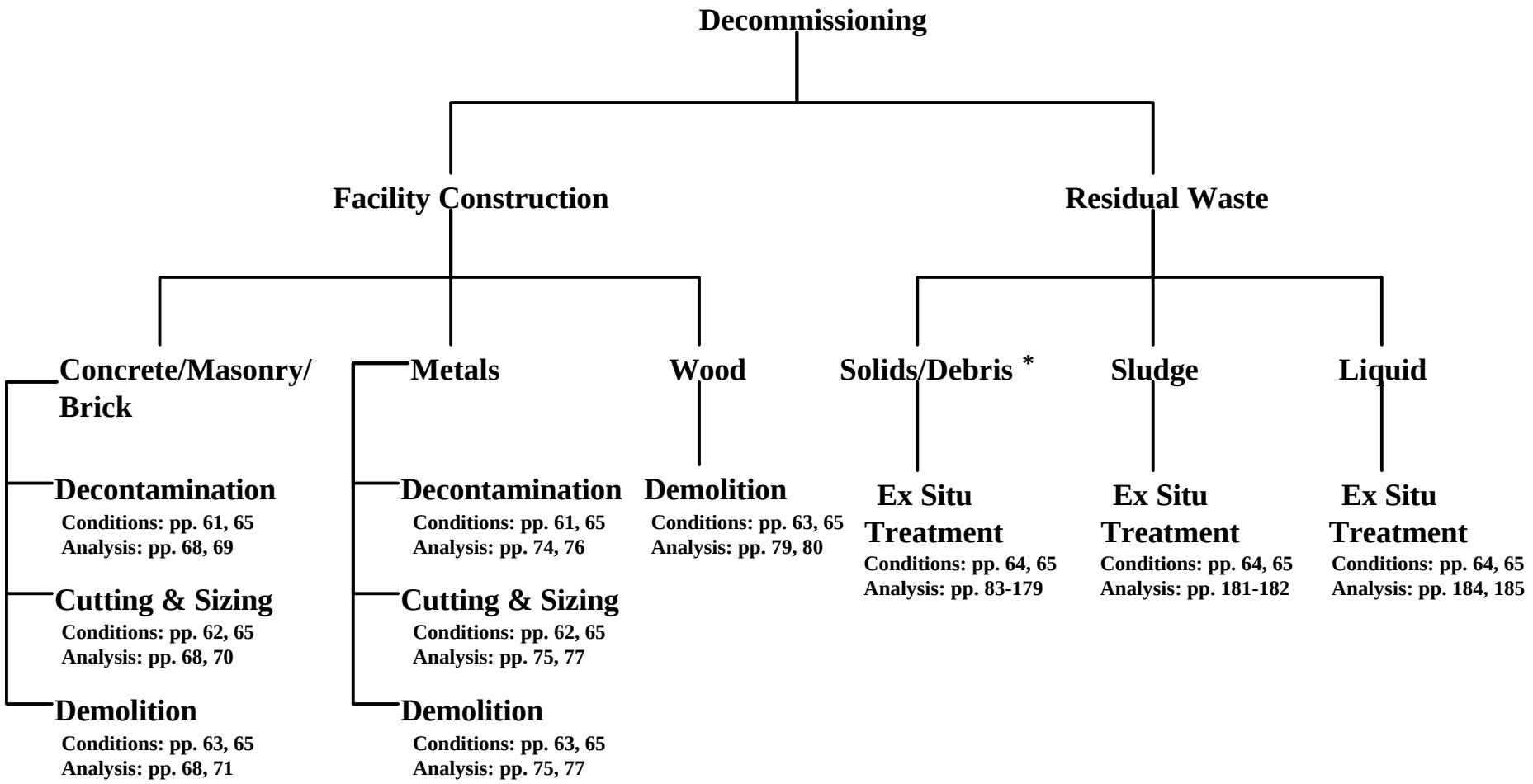


No. of facility conditions with the state of commercial practice in:
5 Green
0 Yellow
0 Red

Cutting/Sizing of Metals



HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR DECOMMISSIONING



* Includes asbestos

THIS ROADMAP SERVES AS A GUIDE THROUGH THE TECHNOLOGY SCREENING ANALYSIS

- A discussion of the definitions and assumptions for the facility conditions and waste composition conditions precedes the technology screening analysis.

- The technology screening analysis follows and includes, by media, the state of commercial practice depicted in the analytic model, summary text, and high-level conclusions.

- Additional roadmaps appear within the technology screening analysis in order to provide a “big picture” view per medium.

THE ANALYTICAL MODEL FOR THE TECHNOLOGY SCREENING ANALYSIS MIRRORS THE LAYOUT OF THE PAM BY ASSESSING THE STATE OF COMMERCIAL PRACTICE BASED ON FACILITY CONDITIONS AND WASTE COMPOSITION

- These conditions allow the PAM user to screen out technology alternatives based on site-specific information.
- The analytical model benefits from this level of detail, because the state of commercial practice varies in many cases depending on the conditions present.
- As a note, the facility conditions in the PAM are organized to reveal the impact of factors considered in the Decommissioning Benchmarking Final Report, namely:
  - accessibility - some technologies may be less suitable in tight spaces, weak structures, and/or in the presence of industrial hazards;
  - airborne contamination/fire hazard - some technologies may result in airborne contamination or elevate the potential for hazard; and
  - exposure - some technologies may not provide adequate radiological protection for workers or, in extreme cases, may not be operable.
- The following pages discuss the environmental conditions and assumptions that define the parameters.

FACILITY CONDITIONS SPECIFIC TO SURFACE DECONTAMINATION

Discriminators	Applicable Media	Reason for Consideration
Floors vs. Walls/Ceilings	Concrete/Masonry/Brick Metals	Operation in typically horizontal position versus vertically or overhead impacts utility and effectiveness of technology options
Large vs. Small Areas	Concrete/Masonry/Brick Metals	Areal extent and accessibility of target surface impacts utility and effectiveness of technology options
Shallow vs. Deep Surficial Contamination	Concrete/Masonry/Brick (≥ or < 1/8") Metals (≥ or < 1/32")	Effective depth of penetration is variable among technology options
Large Components vs. Small Components, Equipment, and Hand Tools	Metals	Component or equipment size can create need for in situ techniques
Hard Crud/Oxide Films vs. Organic Deposits containing U/TRU/FP vs. Uranium Contamination	Meta	Nature of films or deposits dictates success of technology options
Stainless & High Alloy Steels vs Carbon/Low Alloy Steels	Metals	Nature of metal can dictate appropriateness of technology options for use

FACILITY CONDITIONS SPECIFIC TO CUTTING AND SIZING

Discriminators	Applicable Media	Reason for Consideration
Heavily Reinforced Thick Structures vs. Unreinforced Thick Structures vs. Walls and Floors	Concrete/Masonry/Brick	Degree of reinforcement present impacts technology option applicability
Instrument Tubing vs. Small Diameter Pipe vs. Large Diameter Pipe vs. Flat Stock and Pressure Vessels vs. Structural Steel	Metals	Component geometry and size can dictate technology option applicability

FACILITY CONDITIONS SPECIFIC TO DEMOLITION

Discriminators	Applicable Media	Reason for Consideration
Concrete vs. Brick/Cinder Block	Concrete/Masonry/Brick	Discrimination between these media dictates appropriateness of technology options
Reinforced vs. Lightly Reinforced vs. Non-reinforced vs. Stack	Concrete/Masonry/Brick	Presence or absence of reinforcement and degree to which segments are intact dictates appropriateness of technology options
Structure vs. Stack	Concrete/Masonry/Brick	Degree to which segments are intact dictates appropriateness of technology options
Sheating Intact vs. Sheathing Removed	Metals Wood	Presence or absence of sheathing dictates appropriateness of technology options

WASTE COMPOSITION SPECIFIC TO EX SITU TREATMENT

Discriminators	Applicable Media	Reason for Consideration
<1% Total Organic Concentration (TOC)/>1% TOC	Sludge Solids/Debris Liquids	Impacts the effectiveness of the technology, but is not the focus of treatment
Volatile/Semi-Volatiles/Non-Volatiles	Sludge Solids/Debris Liquids	For treatments that rely on the volatility of the organics
Asbestos	Solids/Debris	Represents a unique airborne hazard
Cyanide	Sludge Solids/Debris Liquids	Must be treated per RCRA
Mercury	Sludge Solids/Debris Liquids	Must be treated per RCRA
Tritium	Sludge Solids/Debris Liquids	Allowable emissions per NESHAPS/NPDES

ASSUMPTIONS FOR FACILITY CONDITIONS AND WASTE COMPOSITION CONDITIONS

Discriminators	**Assumptions**
Cyanide	Assumes that cyanide is present at any concentration above zero
Mercury	Assumes a concentration above 0.2 mg/L
TOC	Treatment standards change at TOC > 1% per RCRA
Tritium	Assumes that tritium is present at any concentration above zero
Floors vs. Walls/Ceilings	Walls and ceilings are characterized by vertical or overhead positioning
Large vs. Small Areas	Large areas are those easily accessible areas in excess of 2-3 ft^2, while tight areas are considered any area smaller, adjacent to corners, or in some way obstructed by structural irregularities or equipment, rendering them inaccessible to large pieces of decontamination equipment
Shallow vs. Deep Surficial Contamination	For concrete/masonry/bricks shallow surficial contamination has been defined as contamination that has penetrated <1/8" below the media surface; for metals, shallow surficial contamination has been defined as contamination that has penetrated <1/32" below the media surface; the distinction between metals and concrete/masonry/brick has been made to accommodate the greater surface permeability of the latter
Large Components vs. Small Components, Equipment, and Hand Tools	Large components are considered those whose size precludes immersion in a bath for decontamination purposes, necessitating in situ decontamination
Hard Crud/Oxide Films vs. Organic Deposits containing U/TRU/FP vs. Uranium Contamination	When decontamination system piping and tank internals, the form of contamination present dictates the applicability of the decontamination option

IN ADDITION, SEVERAL LIMITATIONS AND ASSUMPTIONS APPLY TO THE ANALYSIS OF TECHNOLOGIES

- TRU waste is defined as radioactive contamination greater than 100 nCi/g; the technology screening analysis does not consider TRU or high radioactive environments (i.e., remote operations) at this time.

- Sanitary waste is excluded from the PAM and subsequently the technology screening analysis, because it is assumed that a low cost/risk disposal alternative is available for waste that is not contaminated or contaminated at low levels.

- For organic/inorganic and mixed LLW it is unlikely that a single technology exists to treat all constituents of the waste, therefore it is assumed that technologies listed in the PAM can be linked to form a treatment train; for example, a technology for organic can be combined with a technology for inorganic to treat organic/inorganic media.

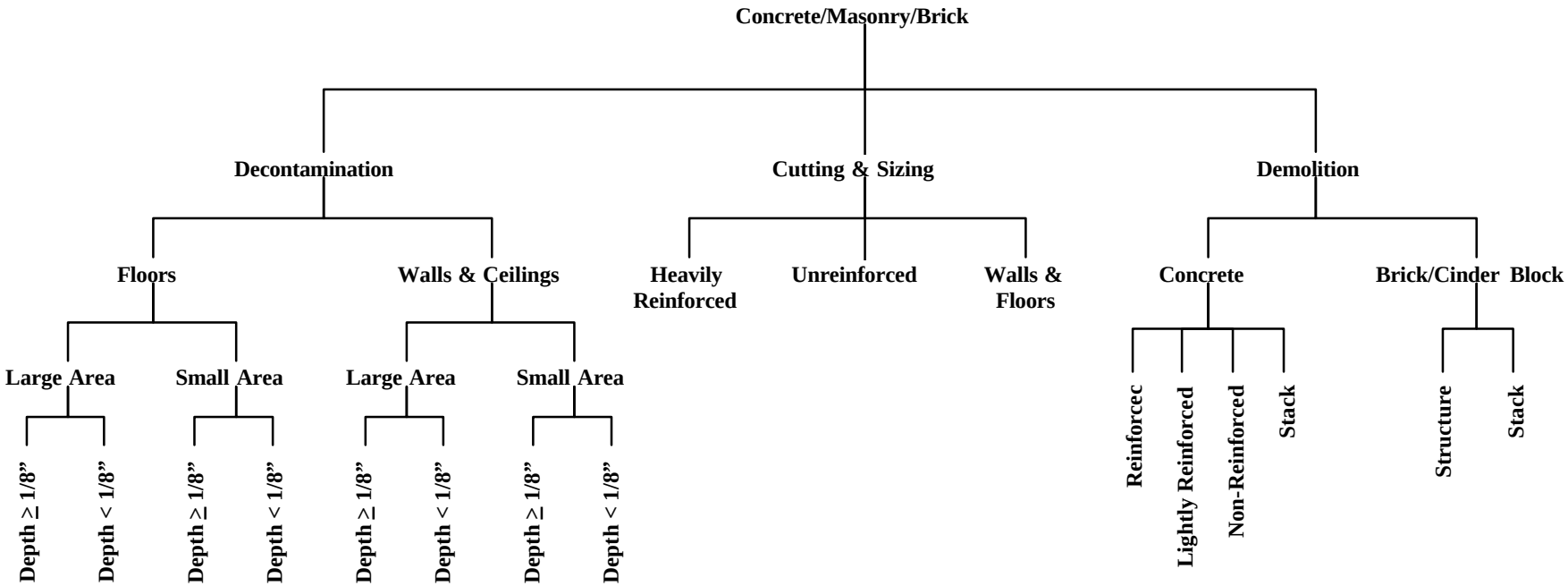
- Low cost pre-treatment is assumed to be available for ex situ treatment.

- “Ex situ treatment” as used in this analysis includes stabilization, thermal and non-thermal treatment, and disposal.

IN ADDITION, SEVERAL LIMITATIONS AND ASSUMPTIONS APPLY TO THE ANALYSIS OF TECHNOLOGIES (CONTINUED)

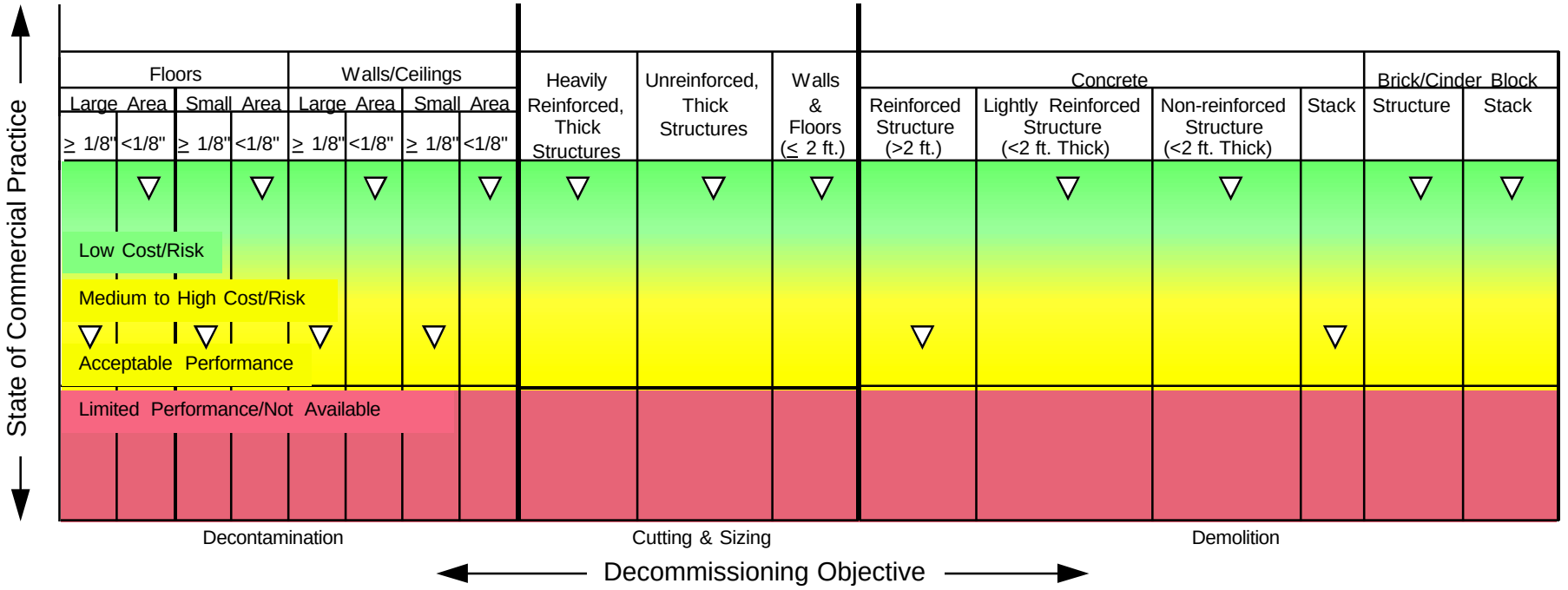
- It is assumed that wood would not be decontaminated or need specialized technologies for cutting and sizing, therefore dismantlement is the only phase of decommissioning analyzed.
- Disposal and stabilization are only analyzed in <1% total organic concentration (TOC) conditions, because at higher levels, TOC must be reduced via treatment before disposal or stabilization.
- Disposal alternatives for asbestos were not evaluated in the Remediation/Waste Processing PAM for asbestos; however it is assumed that low-cost/risk disposal practices are available.
- Applicability of technologies was used to assess availability; hence, if there are no applicable technologies for a specified environmental condition, it was assumed that there are no available technologies.
- Ex situ treatment can be applied to media in the environment (remediation) as well as materials that have been removed from the environment and stored (waste processing) and produced in decommissioning operations; therefore, the conclusions presented in this report for ex situ treatment are consistent with the requirements definition for waste processing and at a higher level of analysis in the requirements definition for remediation.

HIERARCHY OF FACILITY CONDITIONS FOR CONCRETE/MASONRY/BRICK



KEY
Radioactive ▽

CONCRETE/MASONRY/BRICK



Note: Refers to Tables 1, 2, and 3 of the Decommissioning PAM

DECONTAMINATION OF CONCRETE/MASONRY/BRICK SURFACES

- Concrete decontamination technologies do not vary per contaminant.
- Commercial practice provides numerous options through the use of various physical and vacuum/blasting methods for shallow (<1/8") surface contamination.
- Large and small floor conditions, involving contamination that has penetrated to a depth of ≥1/8", are limited to one low-cost/risk technology option each (piston scabbler and paving breaker/chipping hammer, respectively), but have sufficient other technologies with acceptable performance.
- Large and small wall/ceiling conditions, involving contamination that has penetrated to a depth of ≥1/8", are devoid of low-cost/risk technology options, but each have a limited number of technologies with acceptable performance.

CUTTING AND SIZING CONCRETE/MASONRY/BRICK

- Cutting and sizing technologies for concrete/masonry/brick do not vary per contaminant.
- All three of the conditions considered for concrete/masonry/brick are currently satisfied by the state of commercial practice.

DEMOLITION OF CONCRETE/MASONRY/BRICK

- Demolition technologies do not vary by contaminant for concrete/masonry/brick, therefore the following conclusions can be drawn.

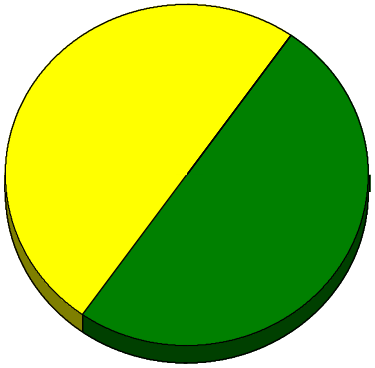
- Commercial practice currently satisfies the technology requirements of the lightly reinforced and non-reinforced concrete structure (<2 ft thick), brick/cinder block structures and brick/cinder block stack problem sets.

- Reinforced (> 2 ft thick) concrete structure conditions are currently limited to a single low-cost/risk technology (backhoe mounted ram), which should be available from multiple vendors; there are numerous other technology options, however they are rated average due to a combination of mediocre performance, cost, and risk.

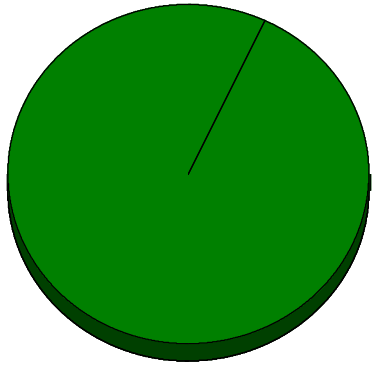
- Concrete stack conditions are limited to a single low-cost/risk technology (expansive grout/demolition compounds).

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR CONCRETE/MASONRY/BRICK PROBLEM SETS[1]

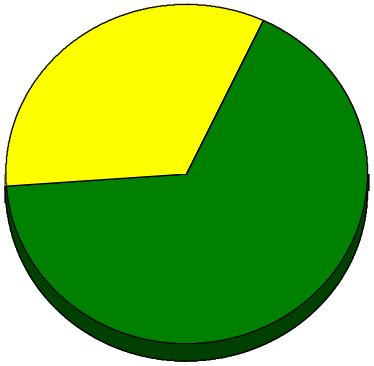
Decontamination



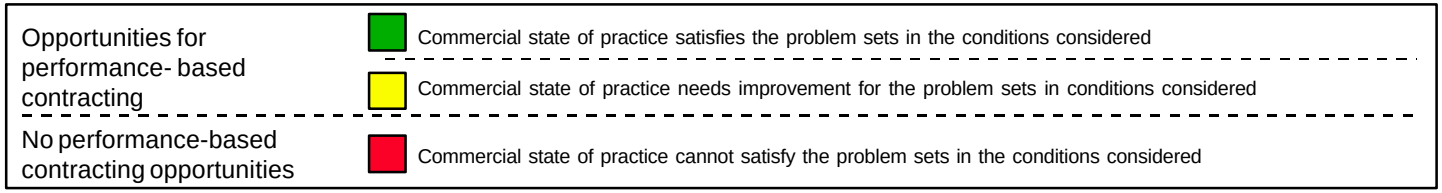
Cutting & Sizing



Demolition

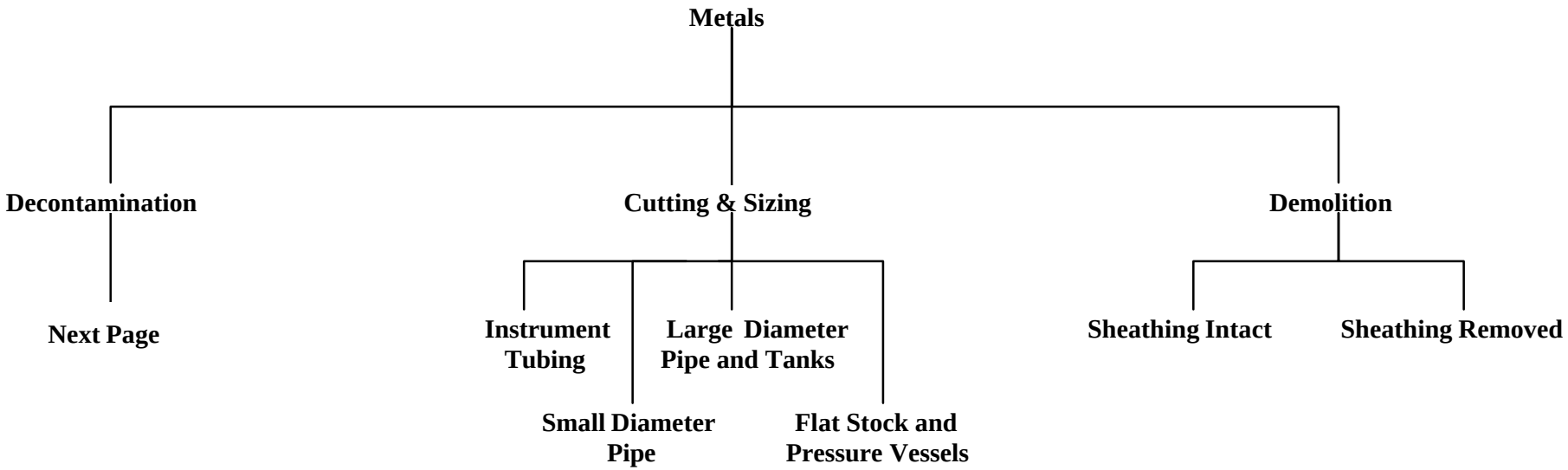


- Commercial practice is available for all conditions considered for cutting and sizing and improvements are necessary in some cases for decontamination and demolition.
- Performance-based contracting opportunities exist for all three phases considered for decommissioning of concrete/masonry/brick.

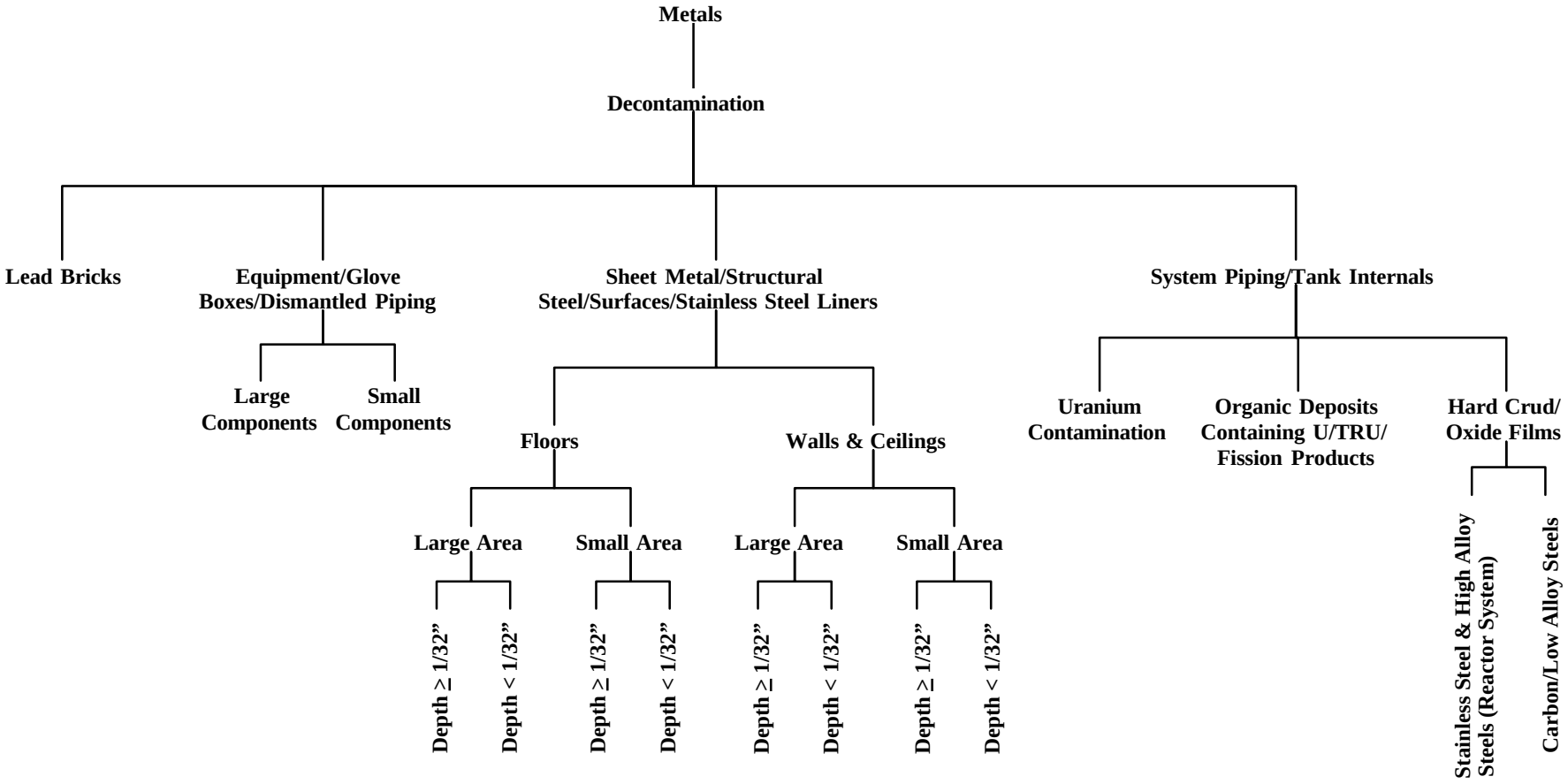


[1] Pie charts represent percentage of conditions in the PAM in which concrete/masonry/brick problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR METALS

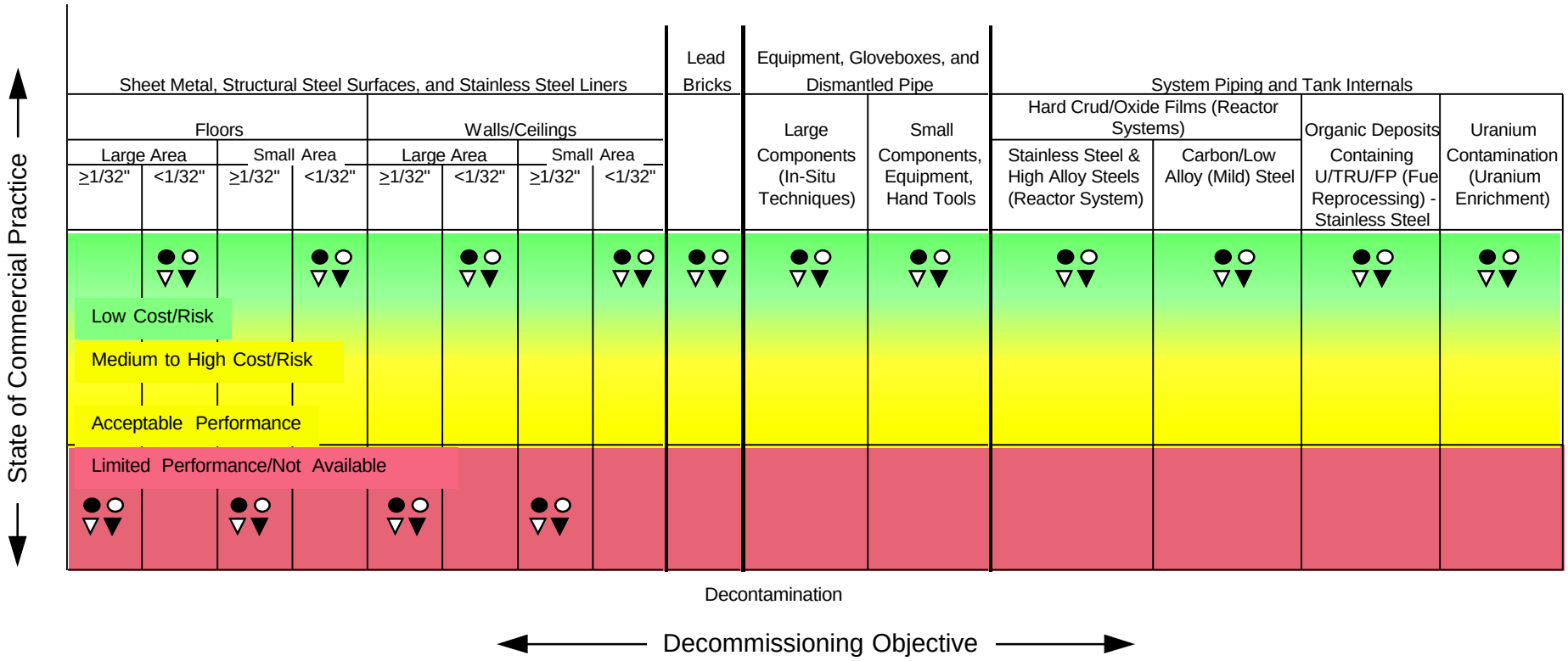


HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR METALS (CONTINUED)

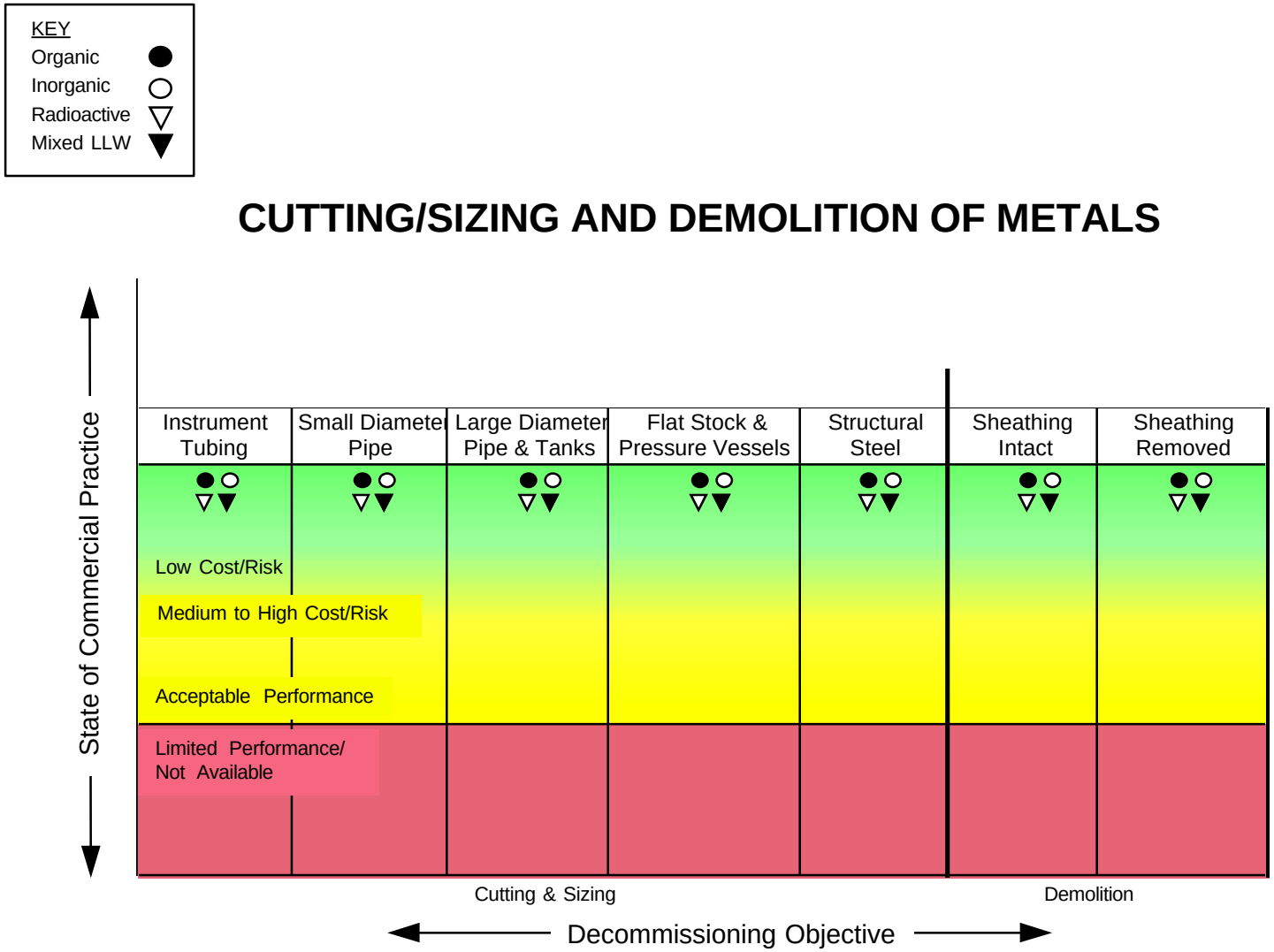


KEY
Organic ●
Inorganic ○
Radioactive ▽
Mixed LLW ▼

DECONTAMINATION OF METALS



Note: Refers to Tables 4, 5, 6, and 7 of the Decommissioning PAM



Note: Refers to Tables 8 and 9 of the Decommissioning PAM

DECONTAMINATION OF METALS

- With the exception of the chemical extraction technology options, technologies do not vary with contamination for decontamination of metals.
- There are multiple low-cost/risk technology options for the decontamination of contamination on sheet metal, structural steel, and stainless steel liners in small areas (<1/32" deep) .
- There are no acceptable technology options for the decontamination of large areas (1≥32") of contamination on sheet metal, structural steel surfaces, or stainless steel liners, clearly demonstrating a need for significant improvement.
- Multiple low-cost/risk technology options are available for the decontamination of lead bricks.
- There are several low-cost/risk technology options for the decontamination of equipment, gloveboxes, and dismantled pipe.
- There are sufficient low-cost/risk and good-performance technology options for all system piping and tank internal conditions.

CUTTING AND SIZING OF METALS

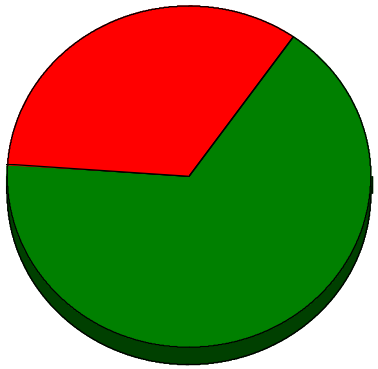
- Cutting and sizing technologies for metals do not vary per contaminant.
- All conditions identified with the cutting and sizing of steel components have a substantial mix of low cost/risk and acceptable technology options.

DEMOLITION OF METALS

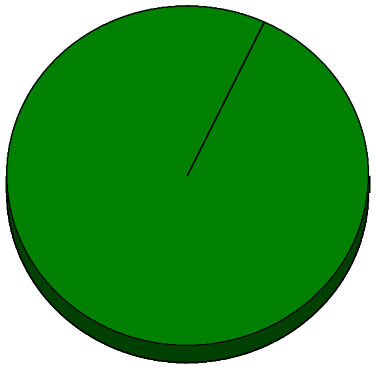
- Demolition technologies for metals do not vary per contaminant.
- Both conditions identified with the demolition of steel structures have a substantial mix of low cost/risk and acceptable technology options.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR METALS PROBLEM SETS[1]

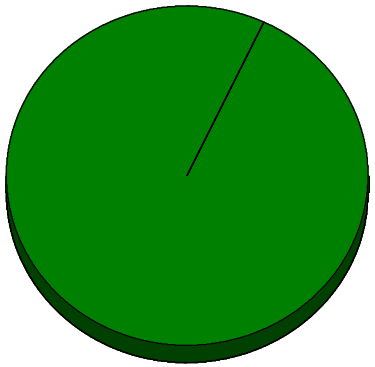
Decontamination



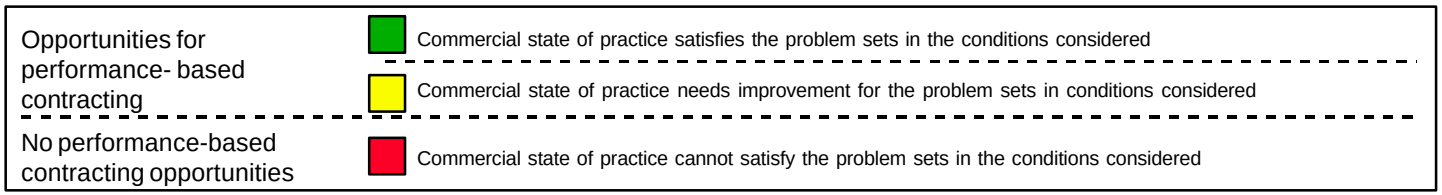
Cutting & Sizing



Demolition

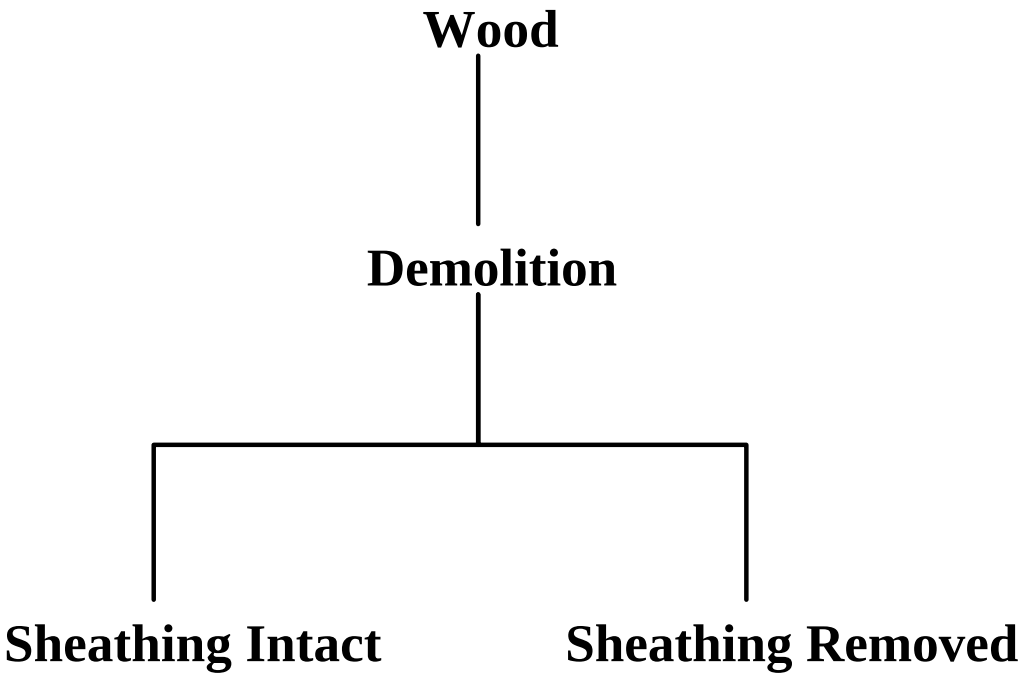


- Commercial practice is available for all conditions considered for cutting and sizing and demolition and is lacking for approximately one-third of the decontamination conditions.
- Numerous performance-based contracting opportunities exist for decontamination, cutting and sizing, and demolition.



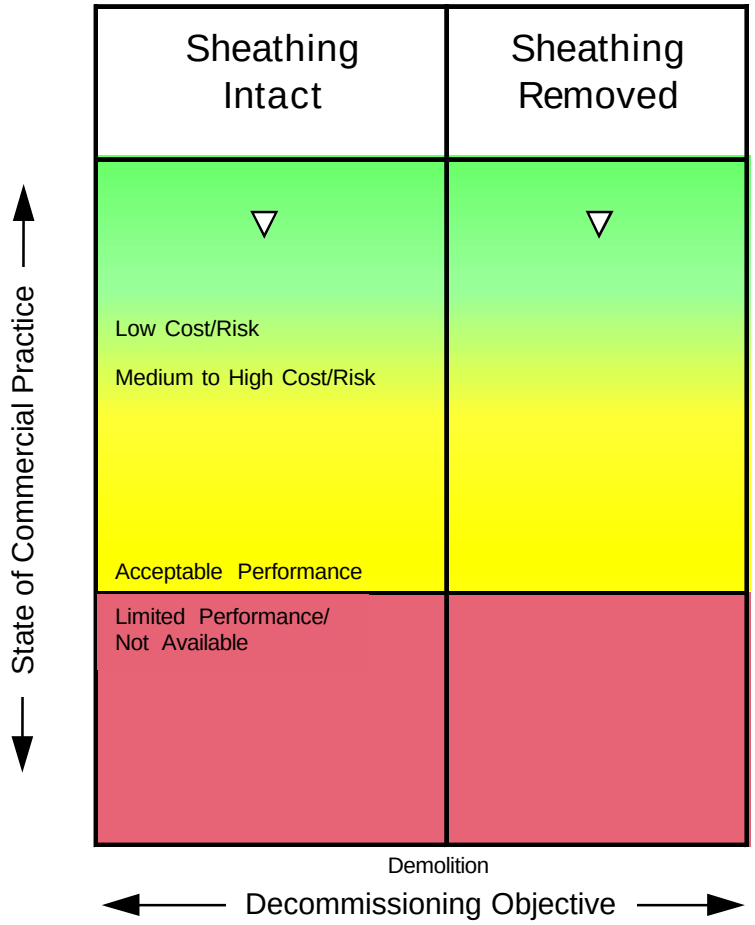
[1] Pie charts represent percentage of conditions in the PAM in which metals problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR WOOD



KEY
Radioactive ▽

DEMOLITION OF WOOD



Note: Refers to Table 10 of the Decommissioning PAM

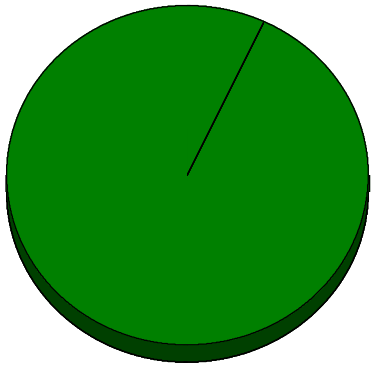
DEMOLITION OF WOOD

- Demolition technologies for wood do not vary per contaminant.

- Both conditions identified with the demolition of wood structures have a substantial mix of low-cost/risk and good-performance technology options.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR WOOD PROBLEM SETS[1]

Demolition

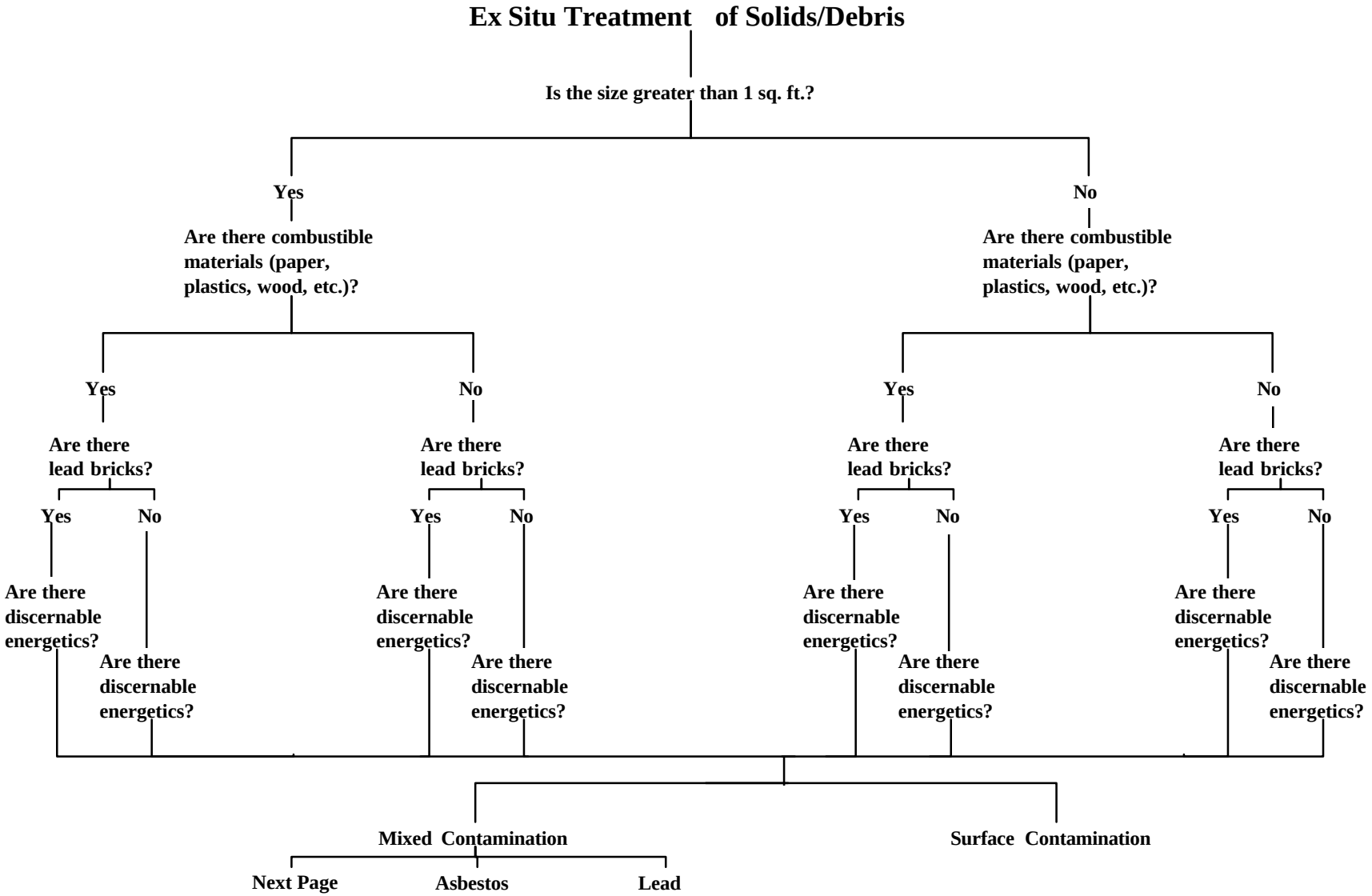


- Commercial practice is available for all conditions considered for demolition of wood.
- Likewise, performance-based contracting opportunities exist for all conditions considered.

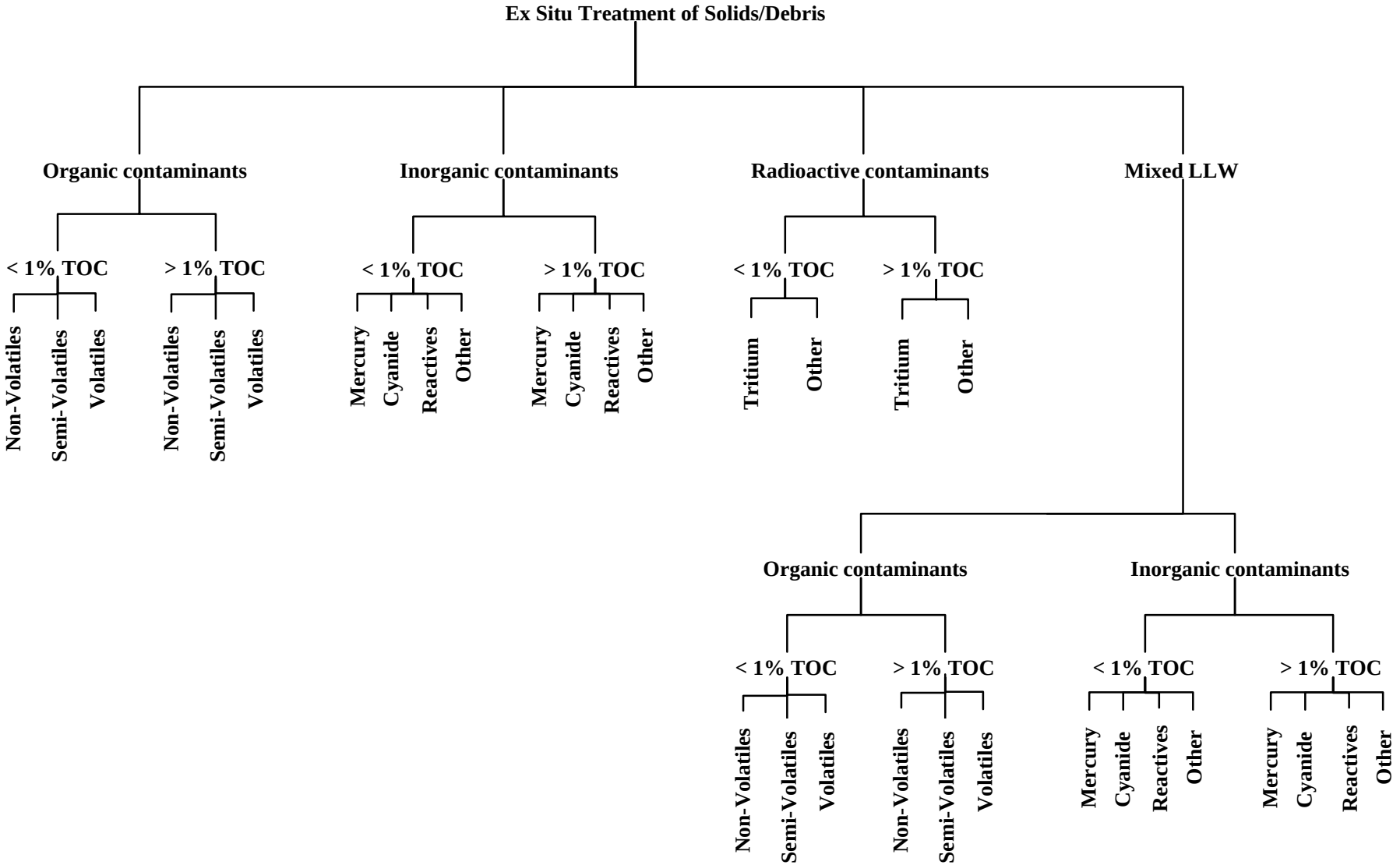
Opportunities for performance- based contracting	Commercial state of practice satisfies the problem sets in the conditions considered
	Commercial state of practice needs improvement for the problem sets in conditions considered
No performance-based contracting opportunities	Commercial state of practice cannot satisfy the problem sets in the conditions considered

[1] Pie charts represent percentage of conditions in the PAM in which wood problem sets can be satisfied, marginally satisfied, or not satisfied; or no technology is necessary.

HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR SOLIDS/DEBRIS



HIERARCHY FOR TECHNOLOGY SCREENING ANALYSIS FOR SOLIDS/DEBRIS (CONTINUED)



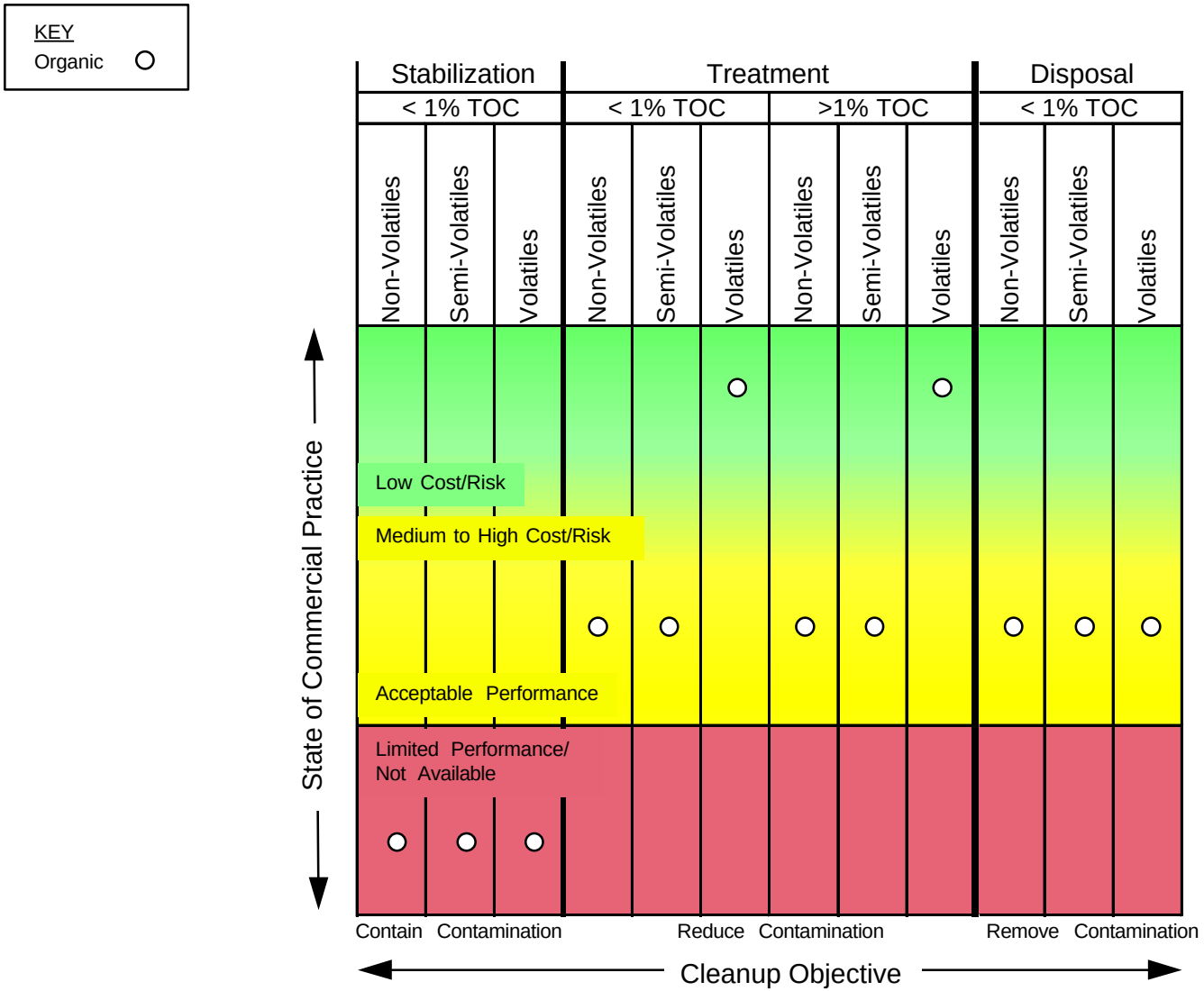
EX SITU TREATMENT OF SOLIDS/DEBRIS PRESENTS A UNIQUE SITUATION WHEN CONSIDERING THE WASTE COMPOSITION CONDITIONS

- The higher level discriminators (size (> 1ft.), combustibles, etc.) affect technology performance, cost, and risk differently when considered separately or in combination.

- For example, commercial practice may satisfy the requirement if size (> 1ft.) is the only consideration, but improvement may be necessary if size (> 1ft.) and combustibles are present.

- As a note, “all other conditions” refers to conditions without size (> 1 ft.), combustibles, lead bricks, or discernable energetics.

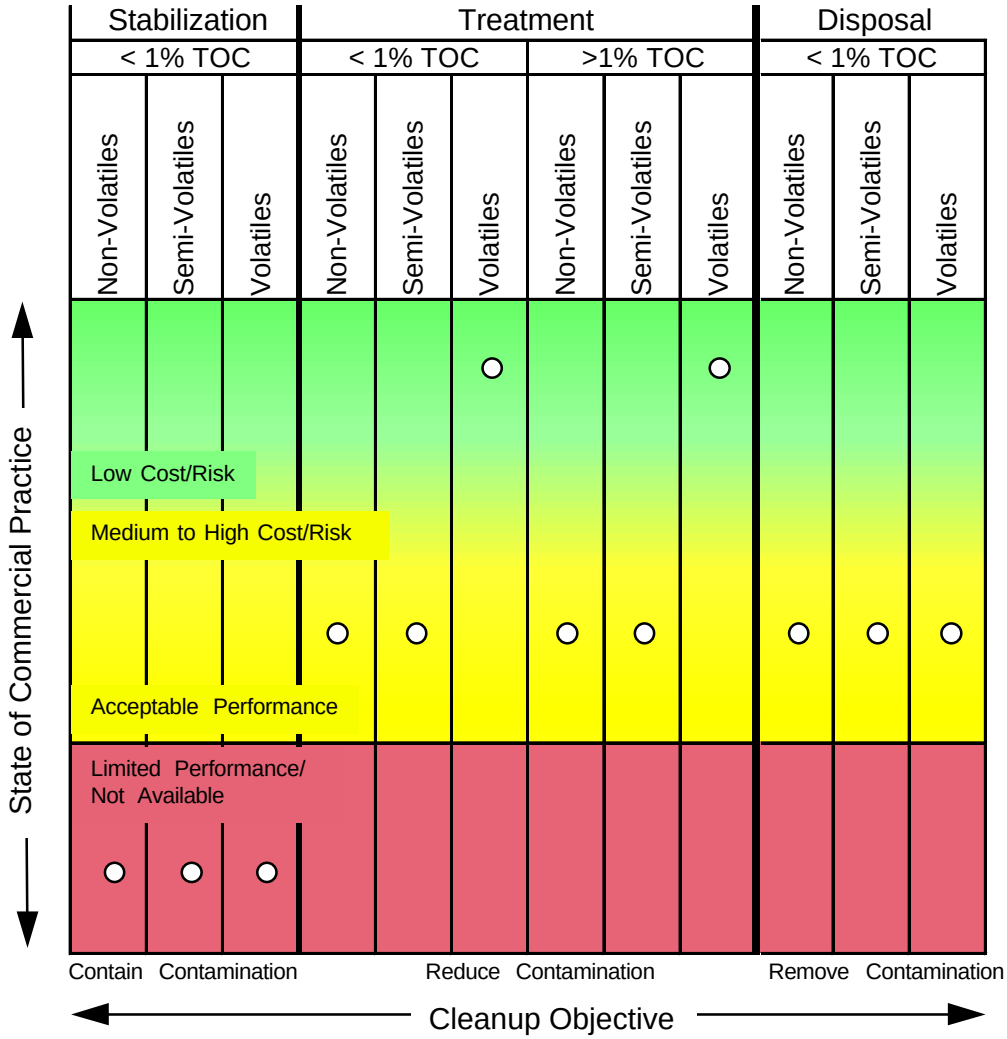
SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT.



Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

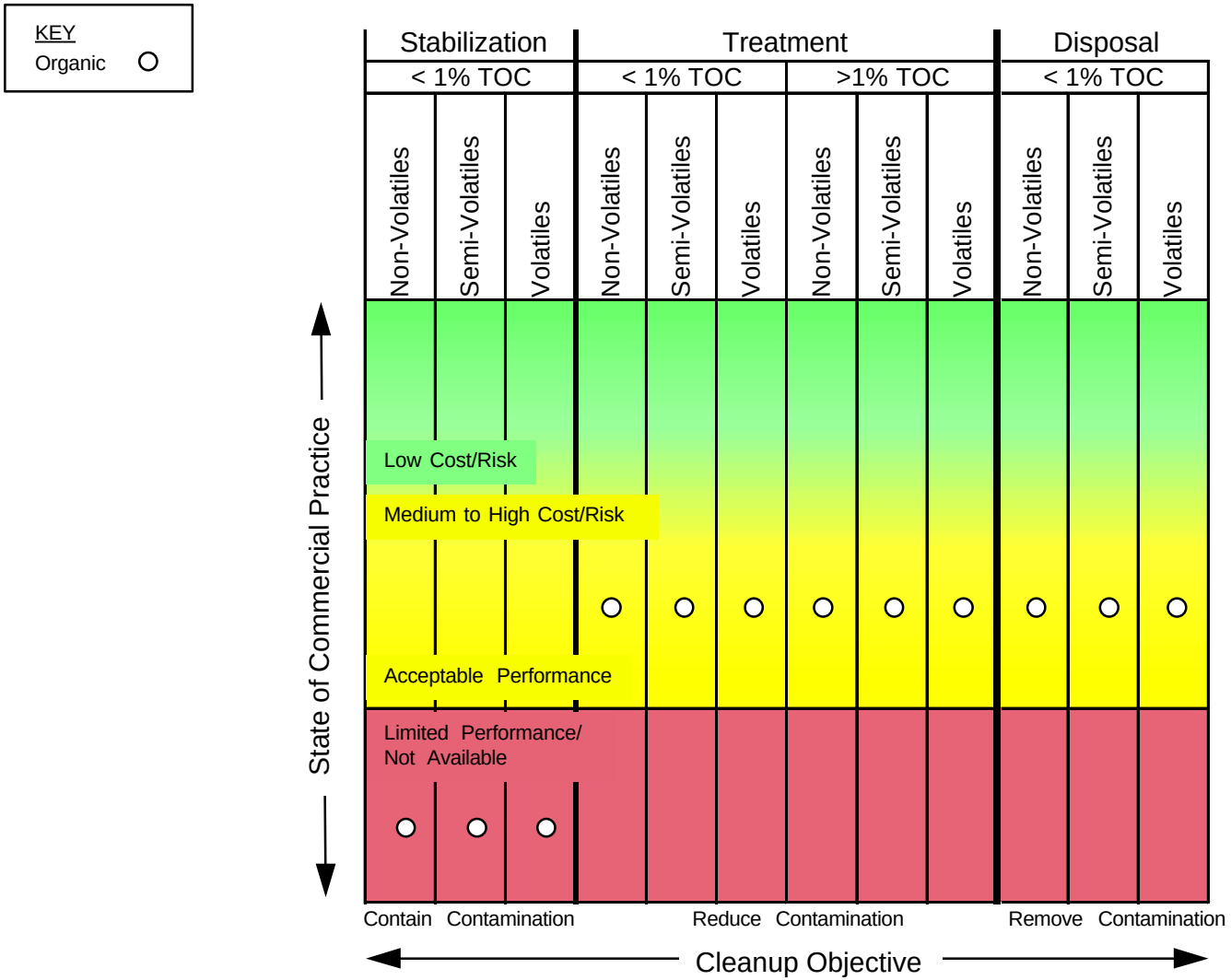
KEY
Organic ○

SOLIDS/DEBRIS - ORGANIC WITH COMBUSTIBLES



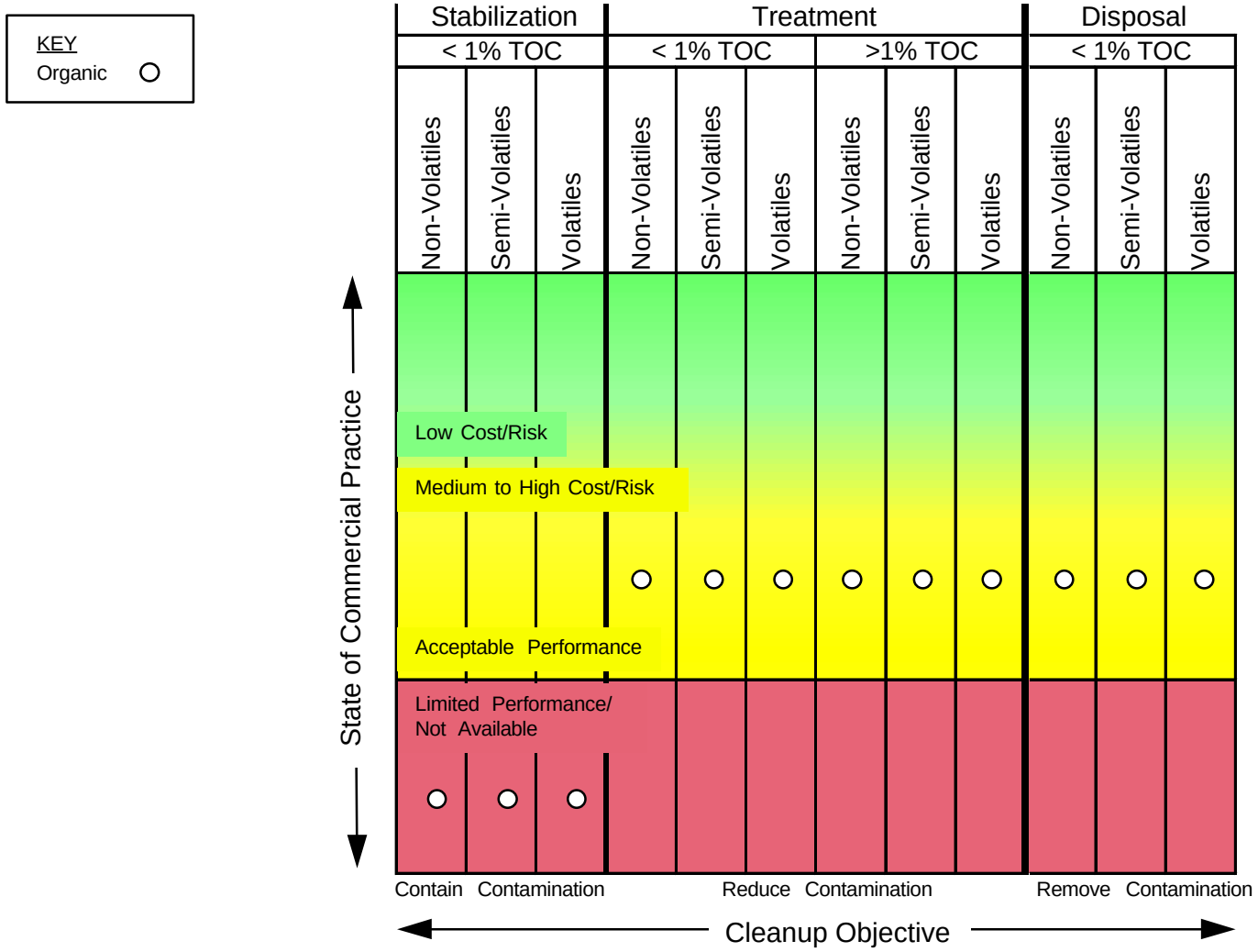
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH LEAD BRICKS



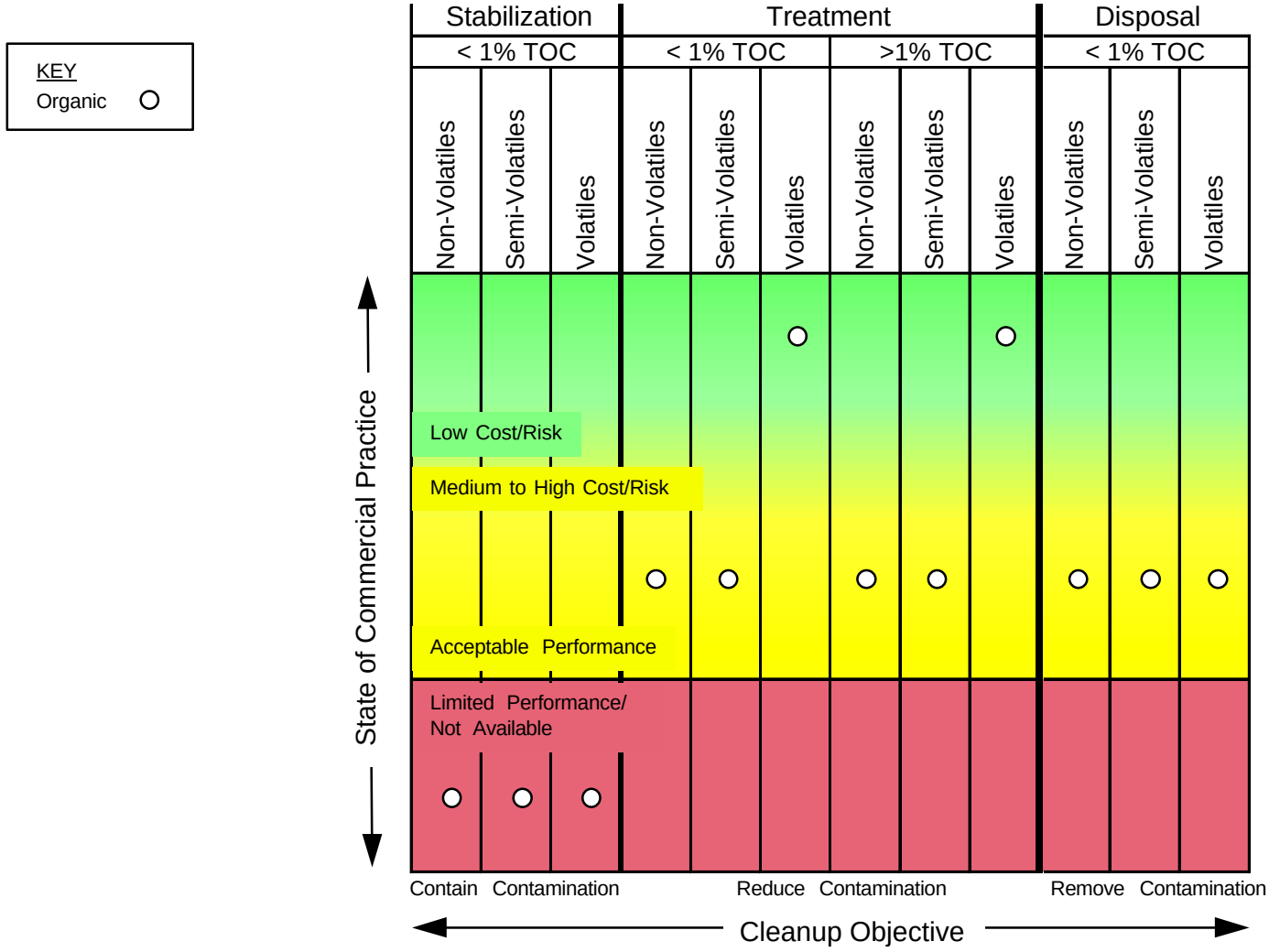
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH DISCERNABLE ENERGETICS



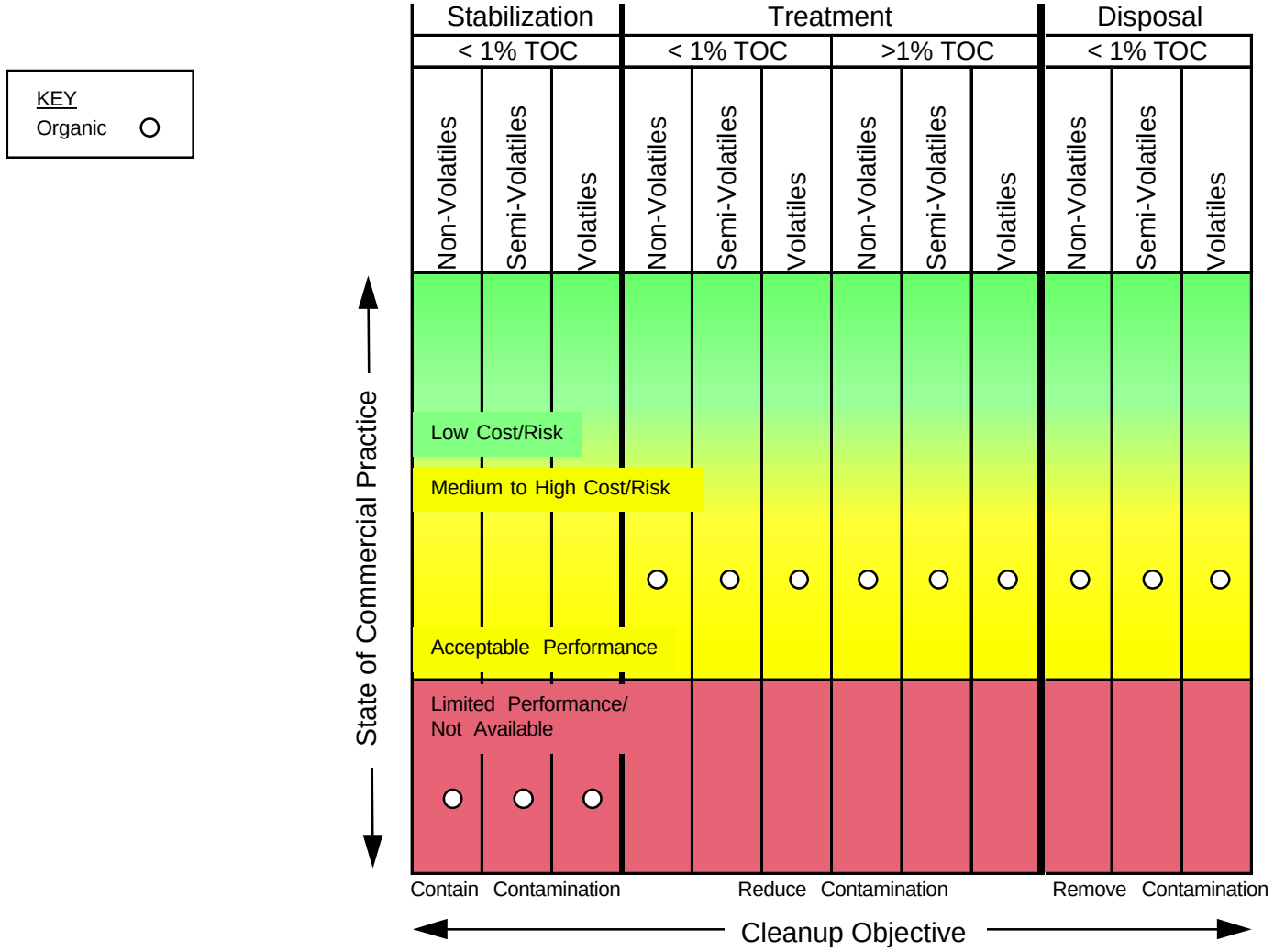
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT. AND COMBUSTIBLES



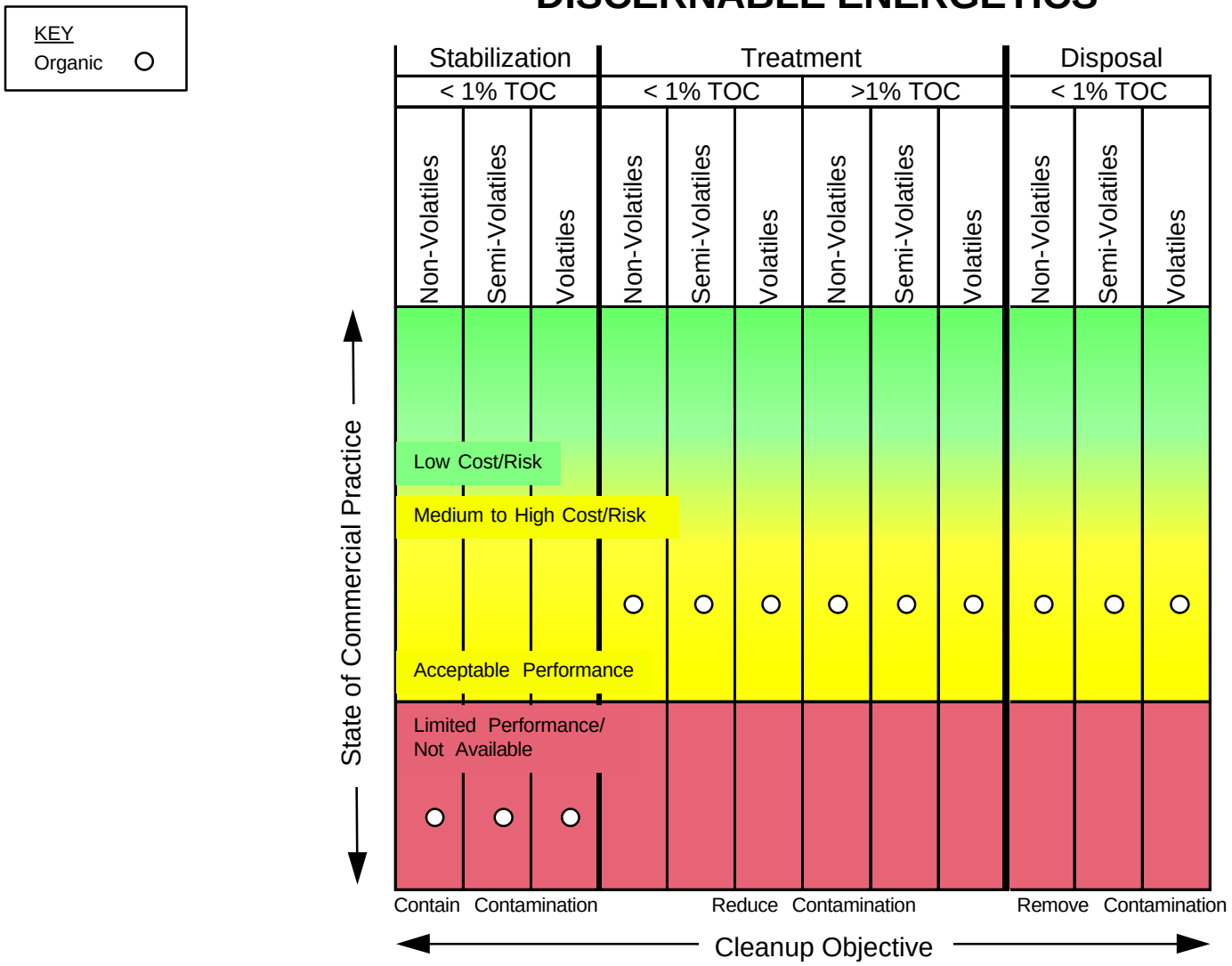
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT. AND LEAD BRICKS



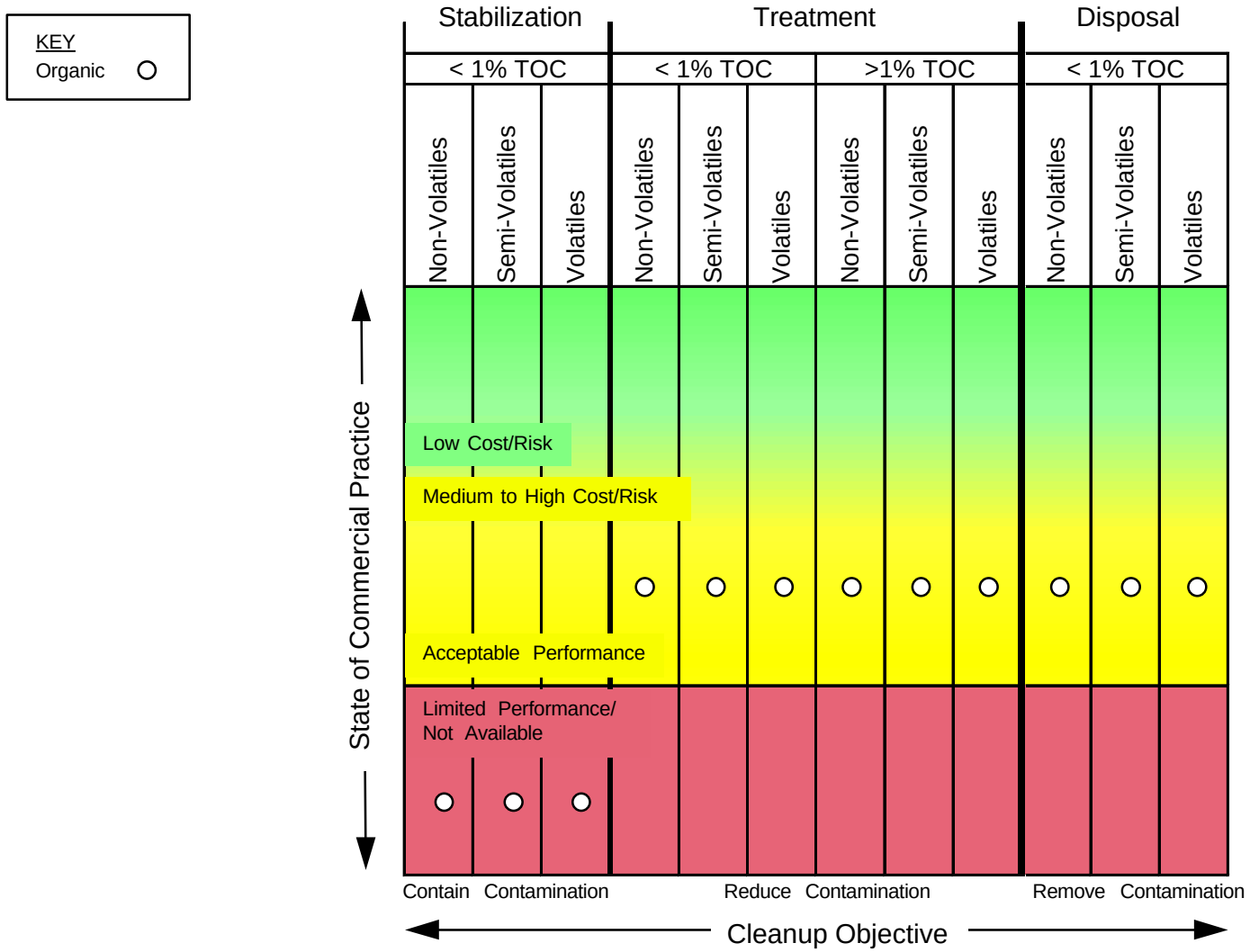
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT. AND DISCERNABLE ENERGETICS



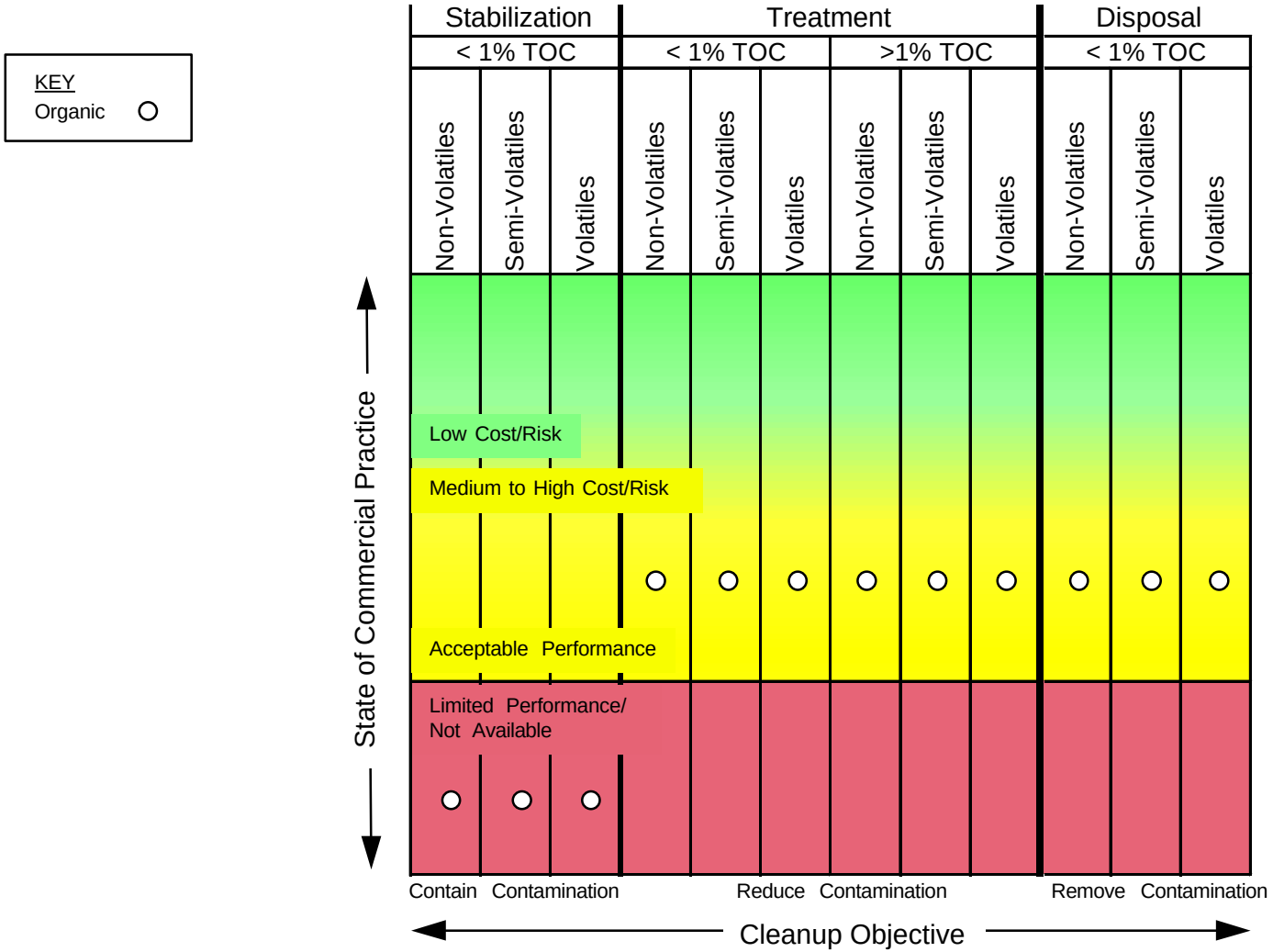
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH COMBUSTIBLES AND LEAD BRICKS



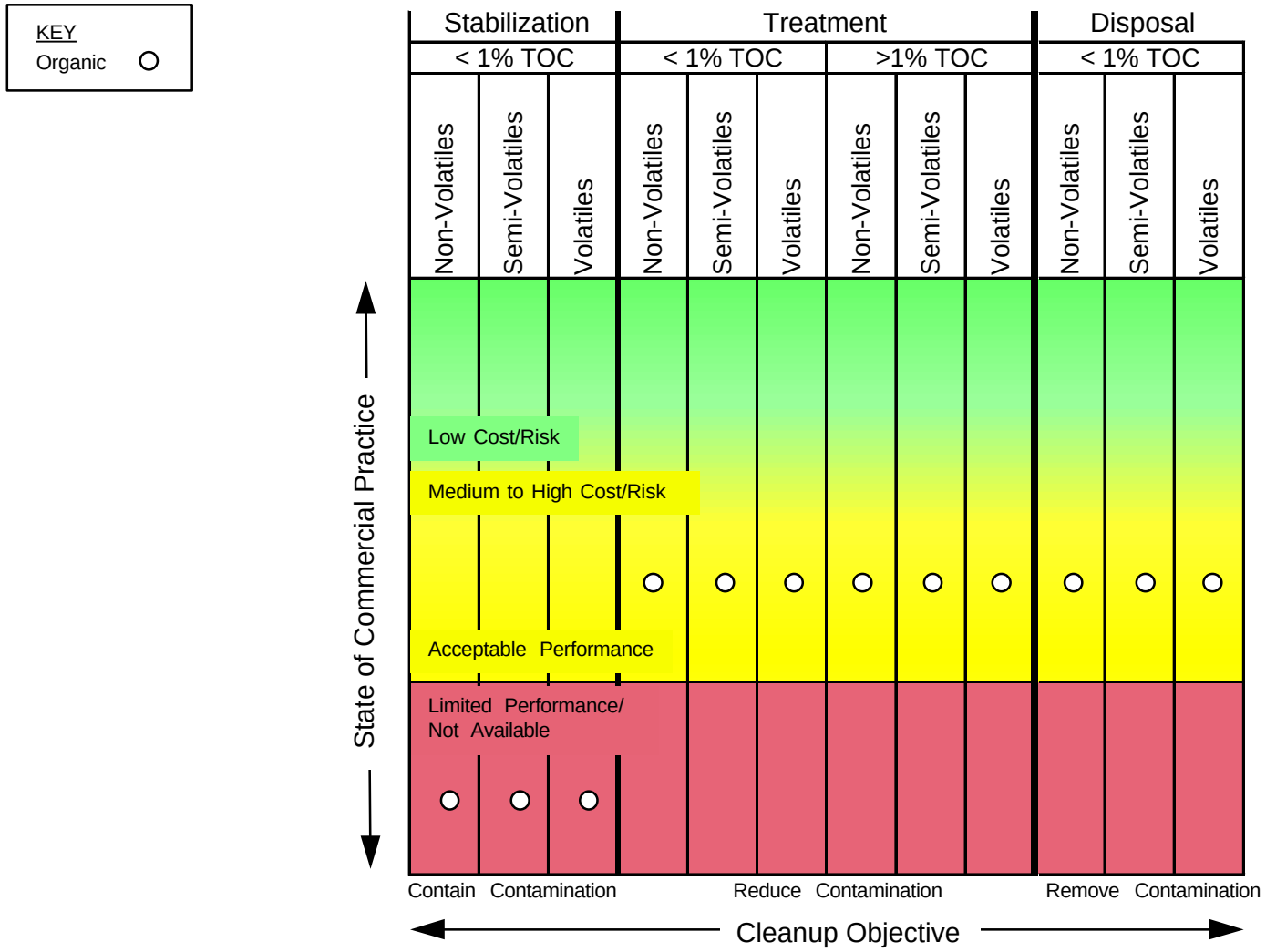
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH COMBUSTIBLES AND DISCERNABLE ENERGETICS



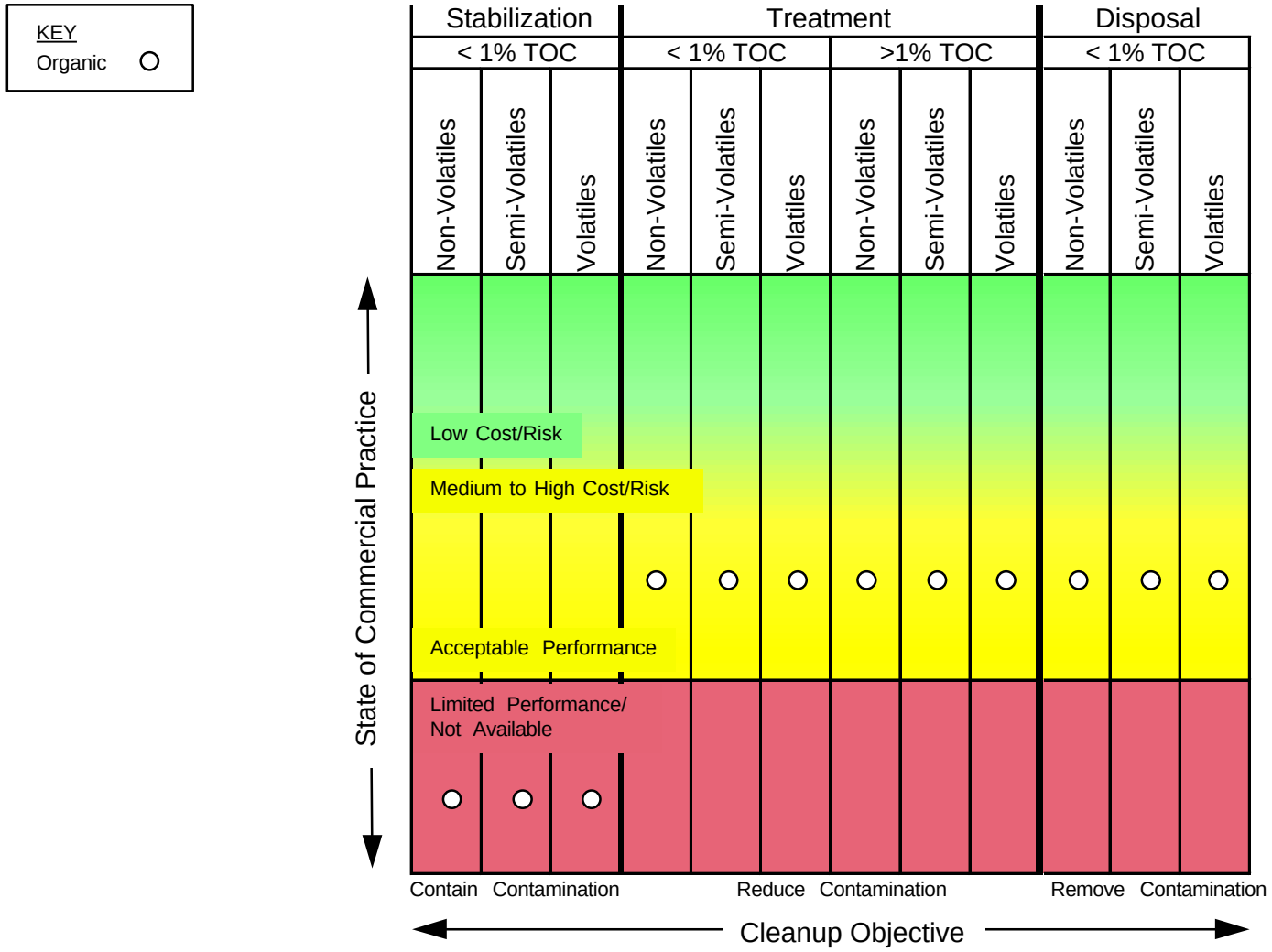
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH LEAD BRICKS AND DISCERNABLE ENERGETICS



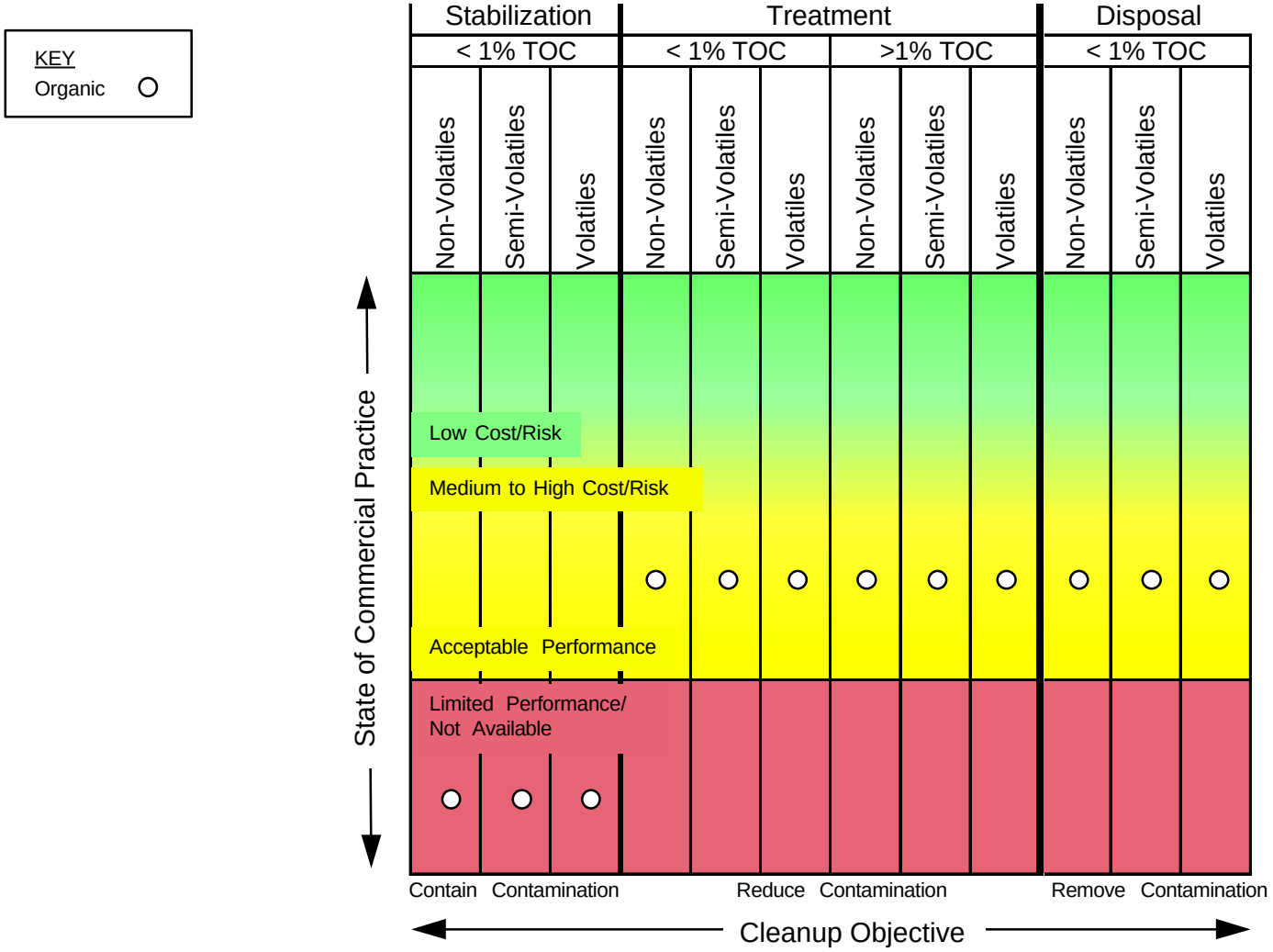
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT., COMBUSTIBLES, AND LEAD BRICKS



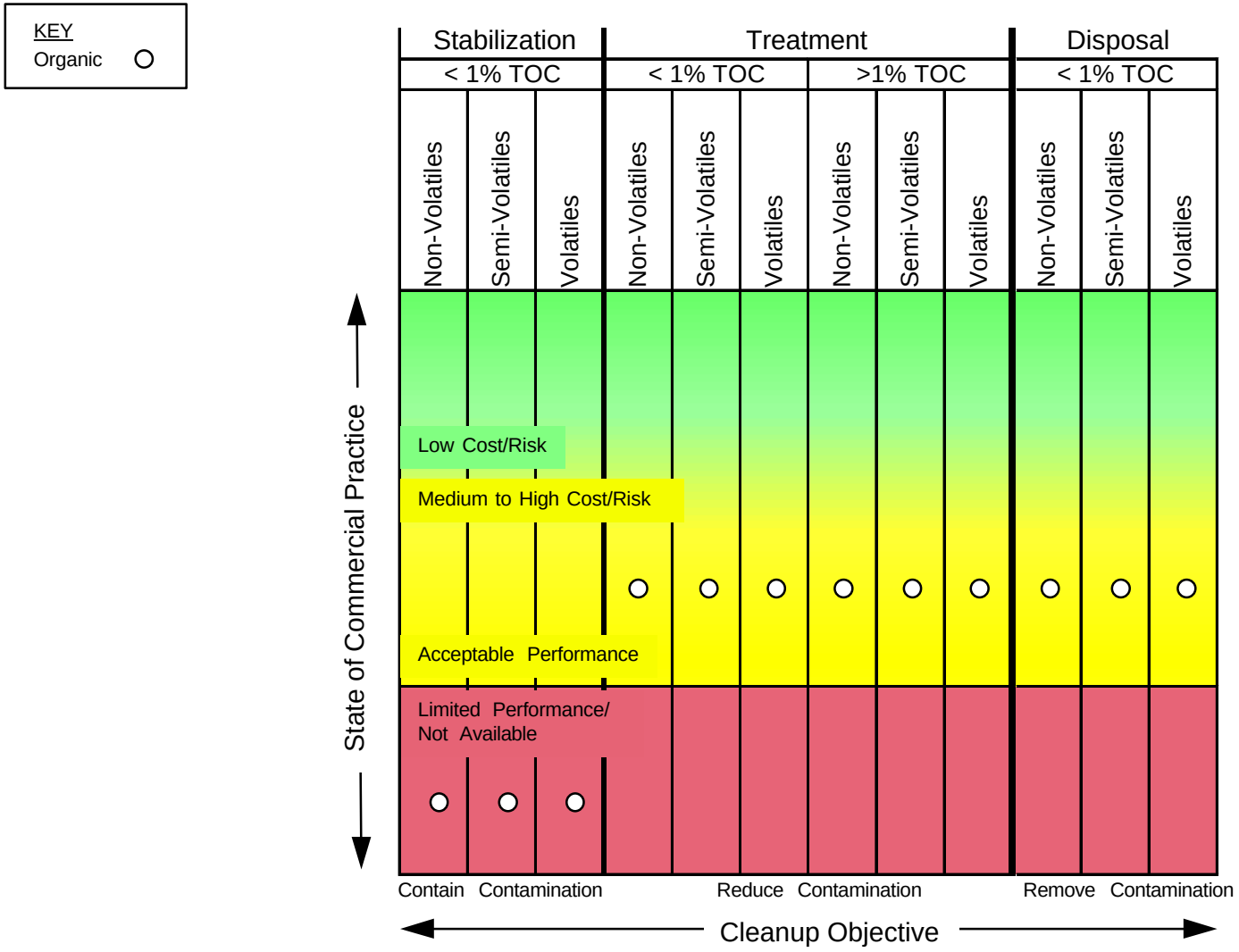
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



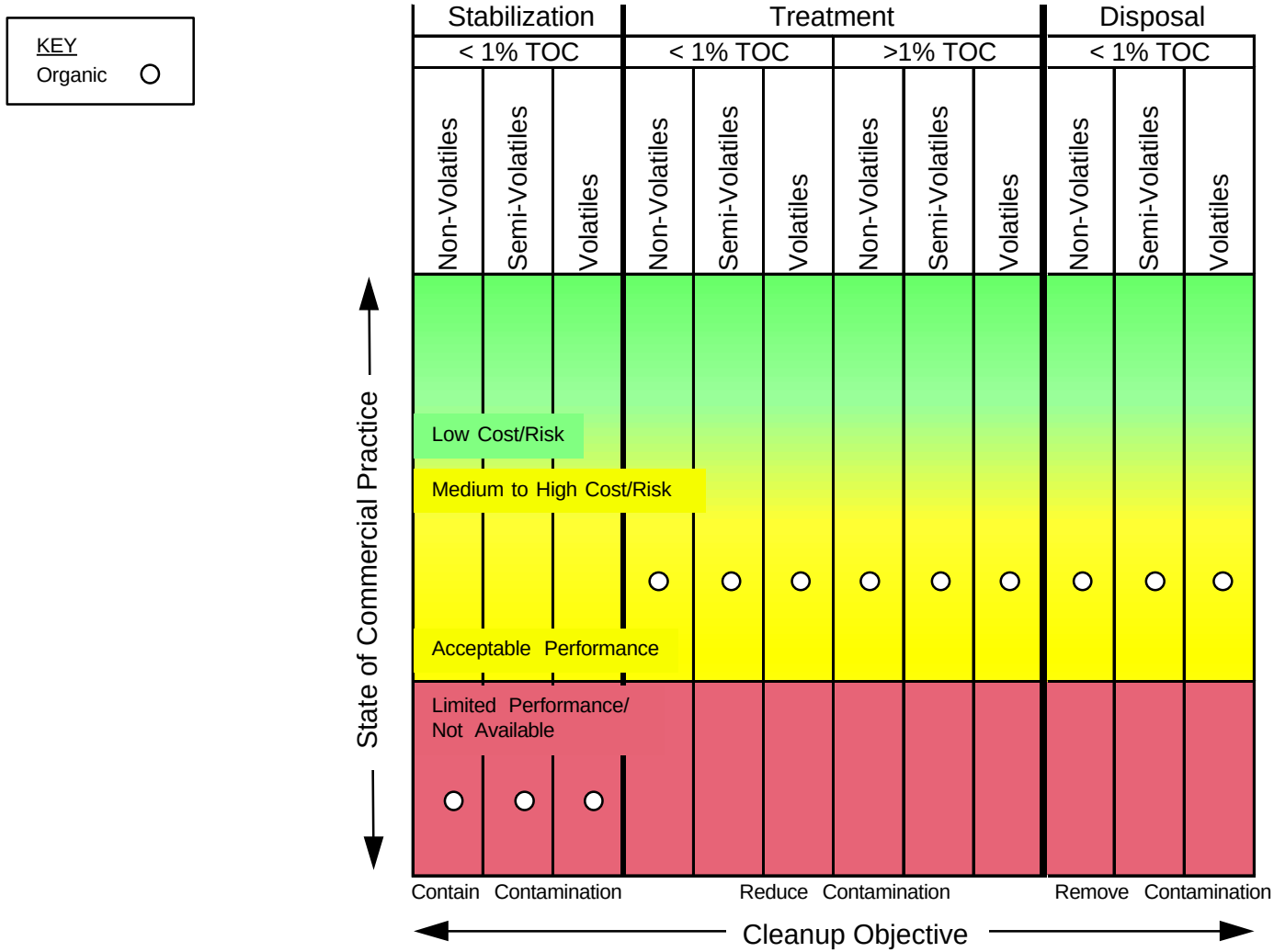
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH SIZE >1FT. , LEAD BRICKS, AND DISCERNABLE ENERGETICS



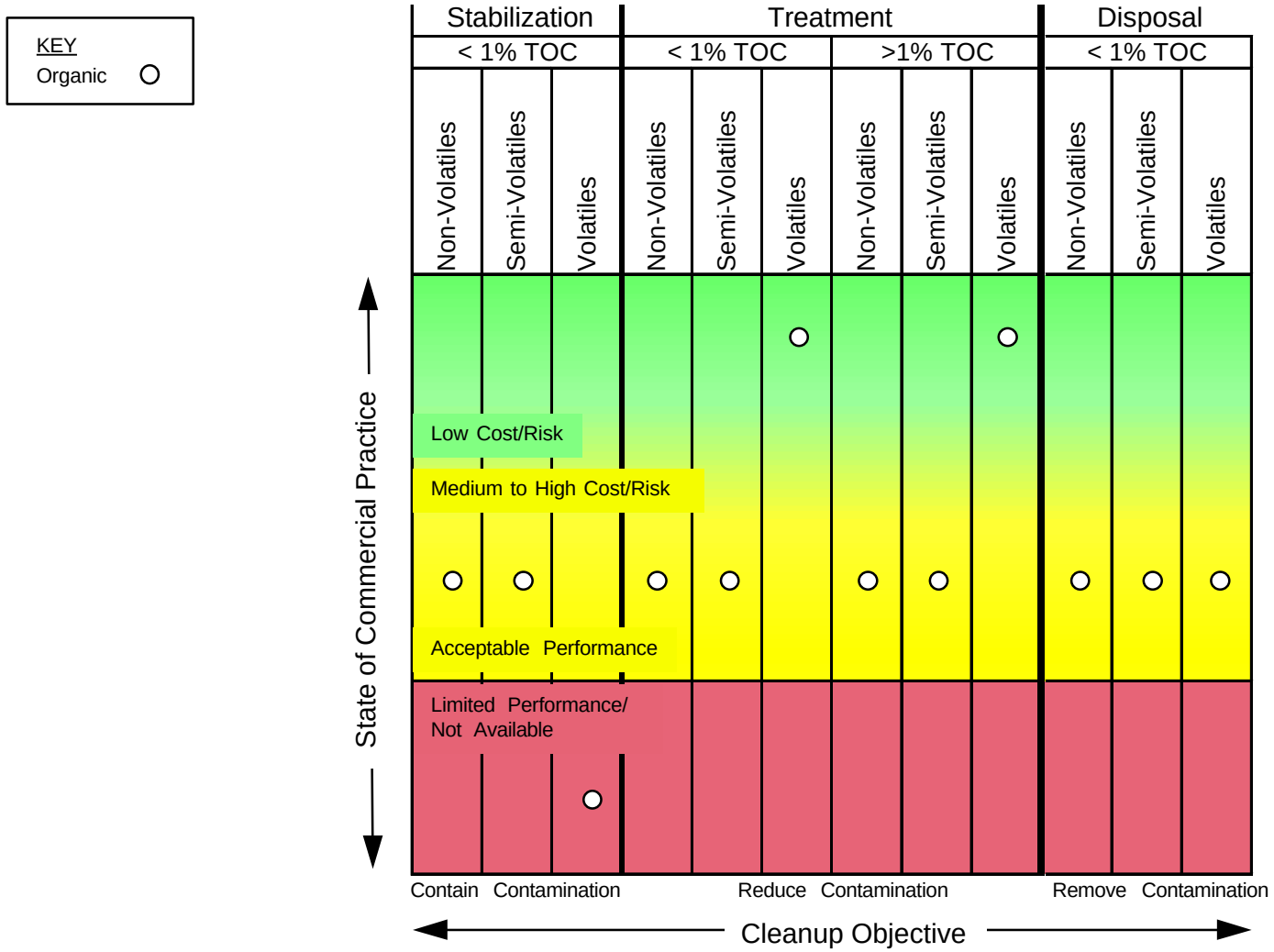
Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC WITH COMBUSTIBLES, LEAD BRICKS, AND DISCERNABLE ENERGETICS



Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - ORGANIC IN ALL OTHER CONDITIONS



Note: Refers to Tables 54 and 55 of the Remediation/Waste Processing PAM

STABILIZATION, TREATMENT, AND DISPOSAL OF SOLIDS/DEBRIS - ORGANIC

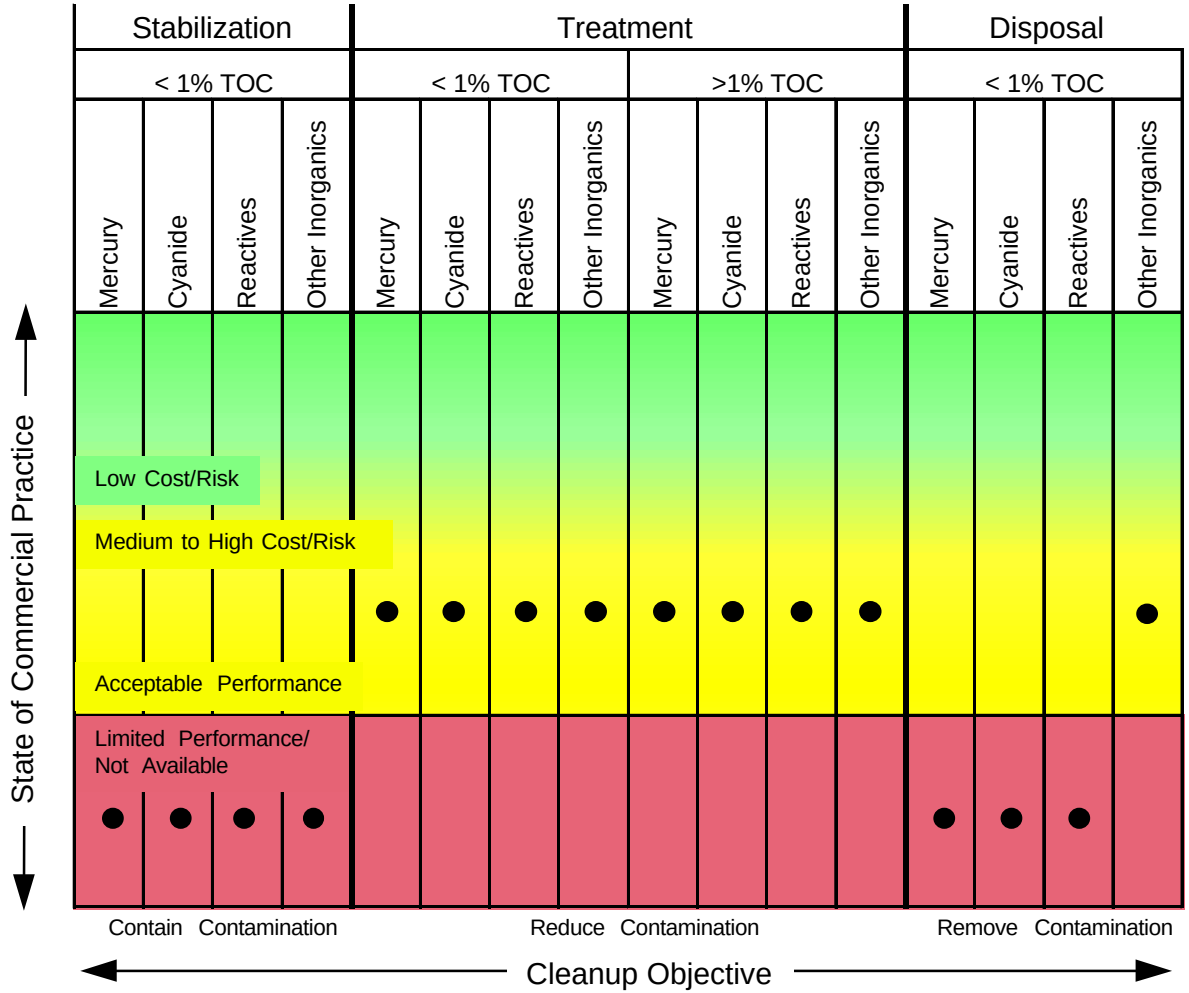
- Good-performance, low-cost/risk stabilization technologies are lacking for all of the high-level conditions considered; where size is less than 1ft. and no combustibles, lead bricks, or discernable energetics are present, improvements are necessary as inorganic encapsulation is the only good-performance, low-cost/risk alternative for non-volatiles and semi-volatiles.

- Improvement is needed to treatment in all conditions with lead bricks or discernable energetics present; conversely, good-performance, low-cost/risk alternatives are available in conditions with volatiles and size greater than 1 ft. and/or combustibles present where drying/dewatering and low temperature thermal desorption are available to meet the requirement.

- Two types of landfills are available for organics in less than 1% TOC conditions, however improvement is needed due to the medium- to high- cost/risk of these alternatives.

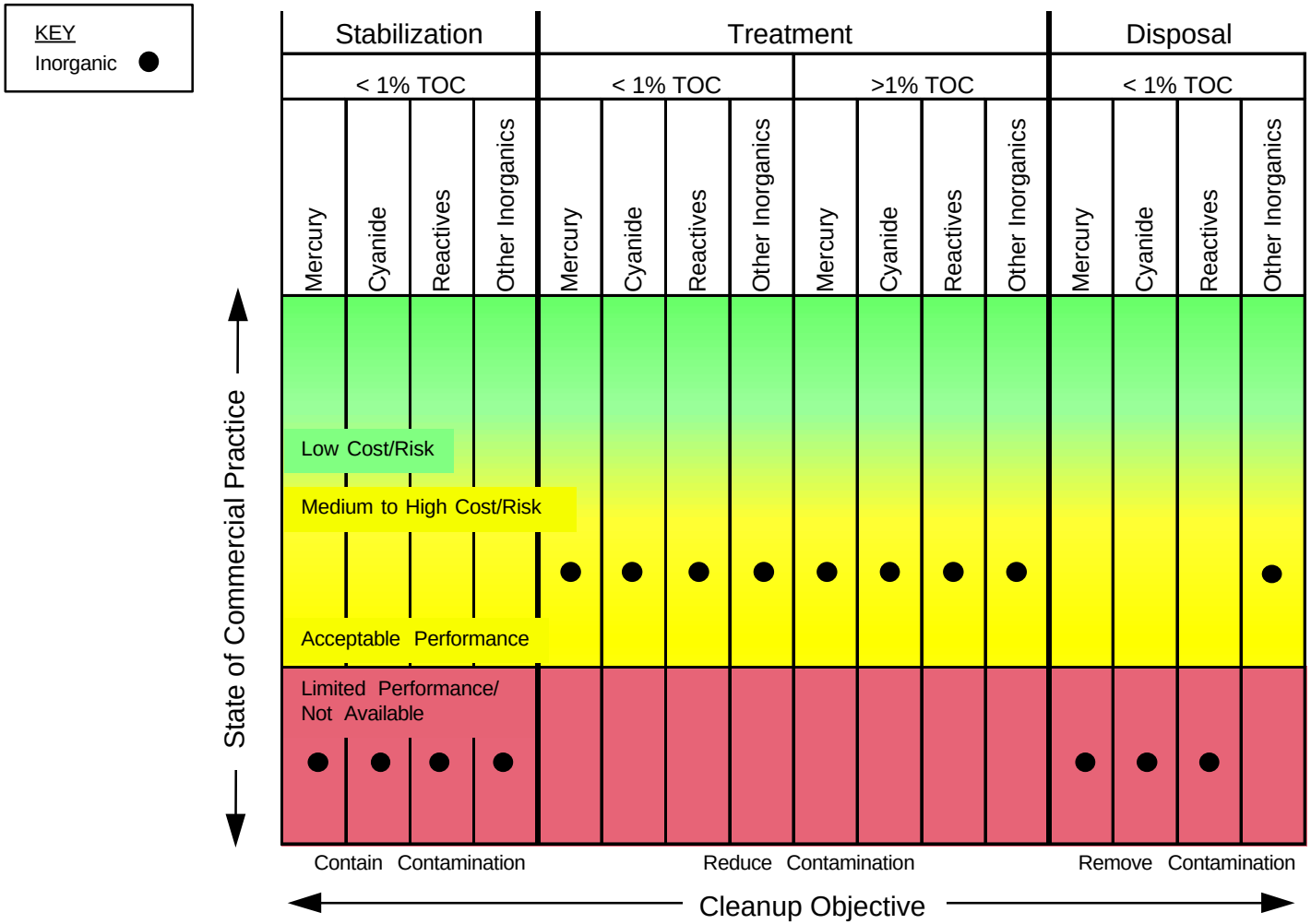
KEY
Inorganic ●

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT.



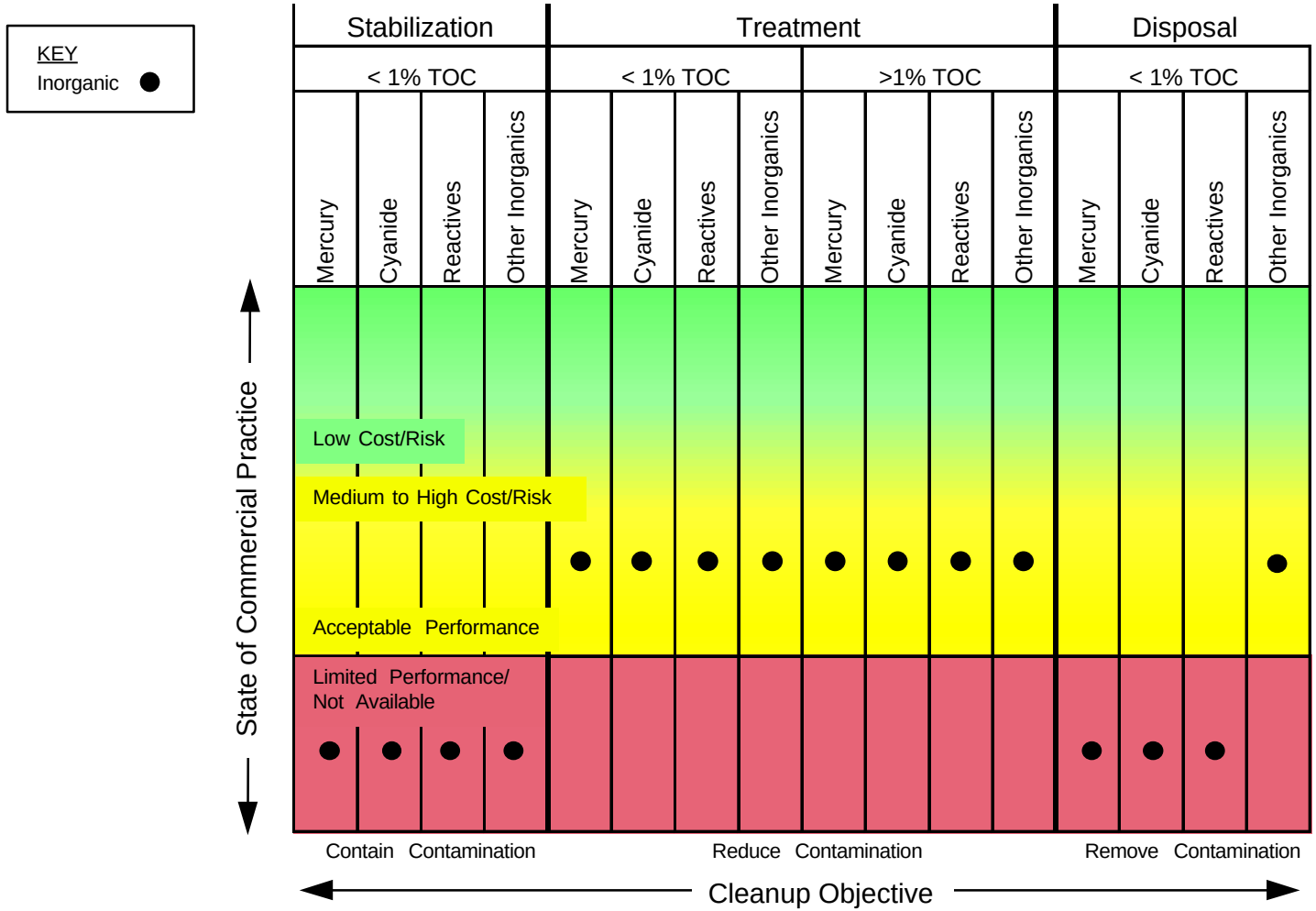
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH COMBUSTIBLES



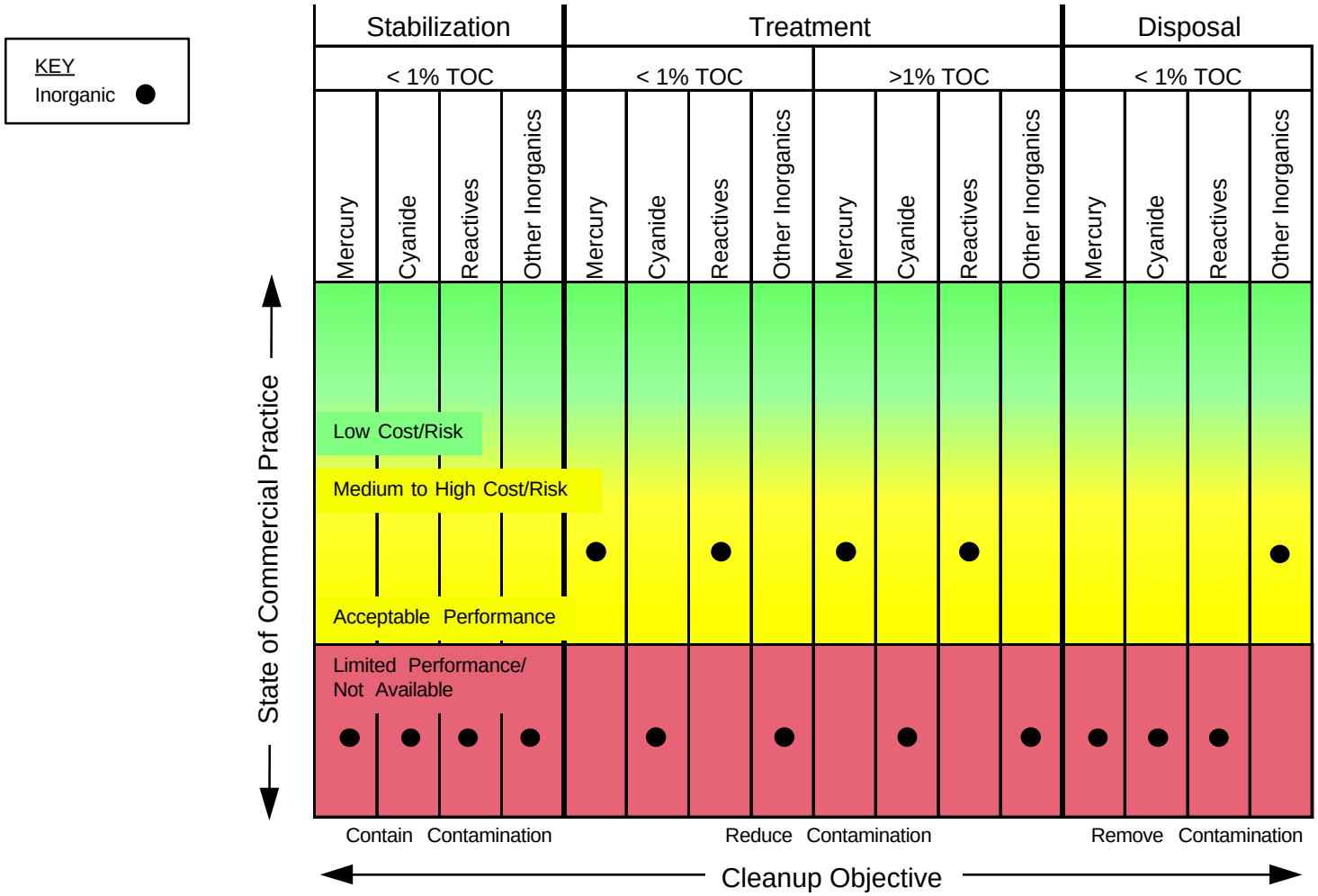
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH LEAD BRICKS



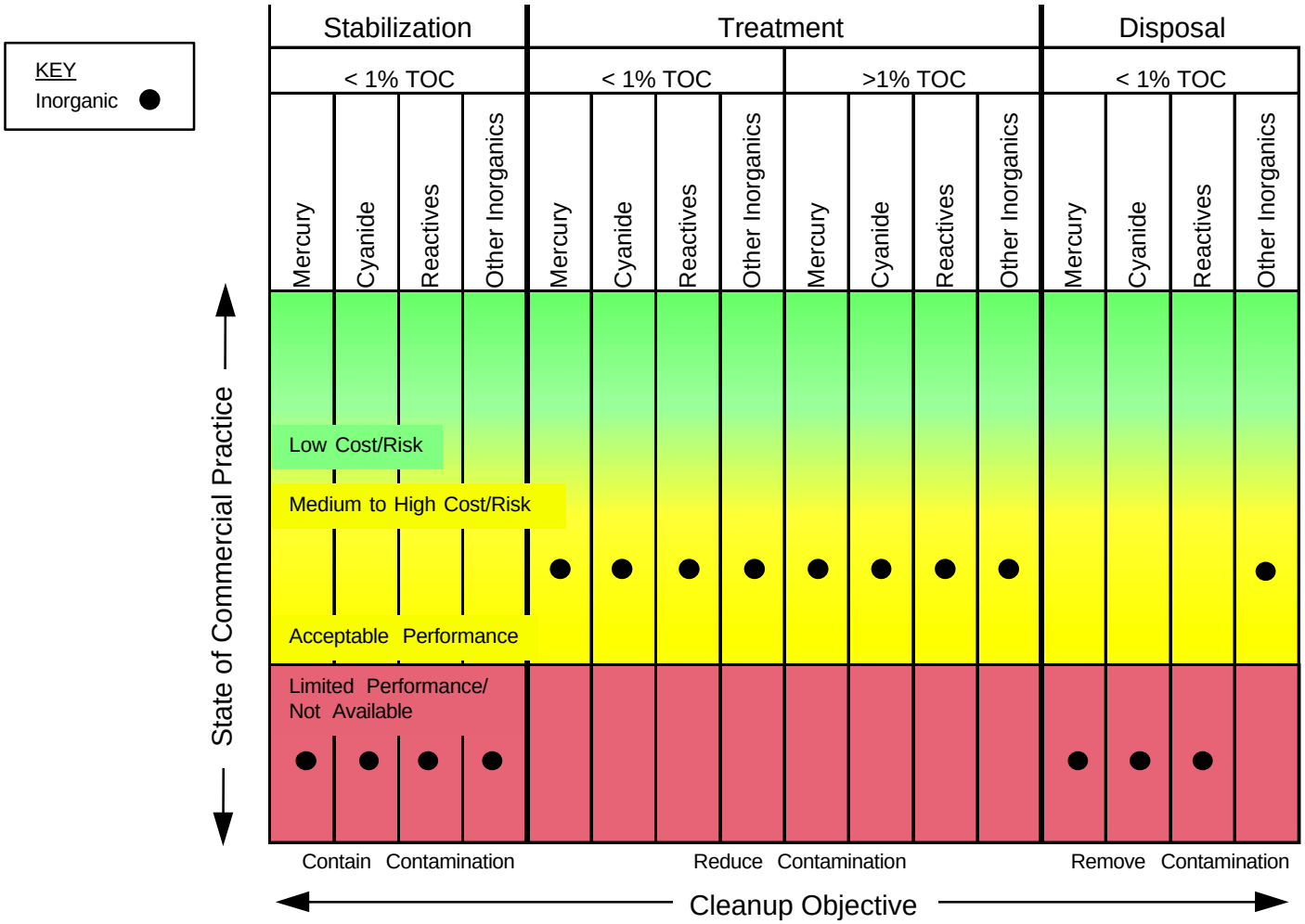
Note: Refers to tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH DISCERNABLE ENERGETICS



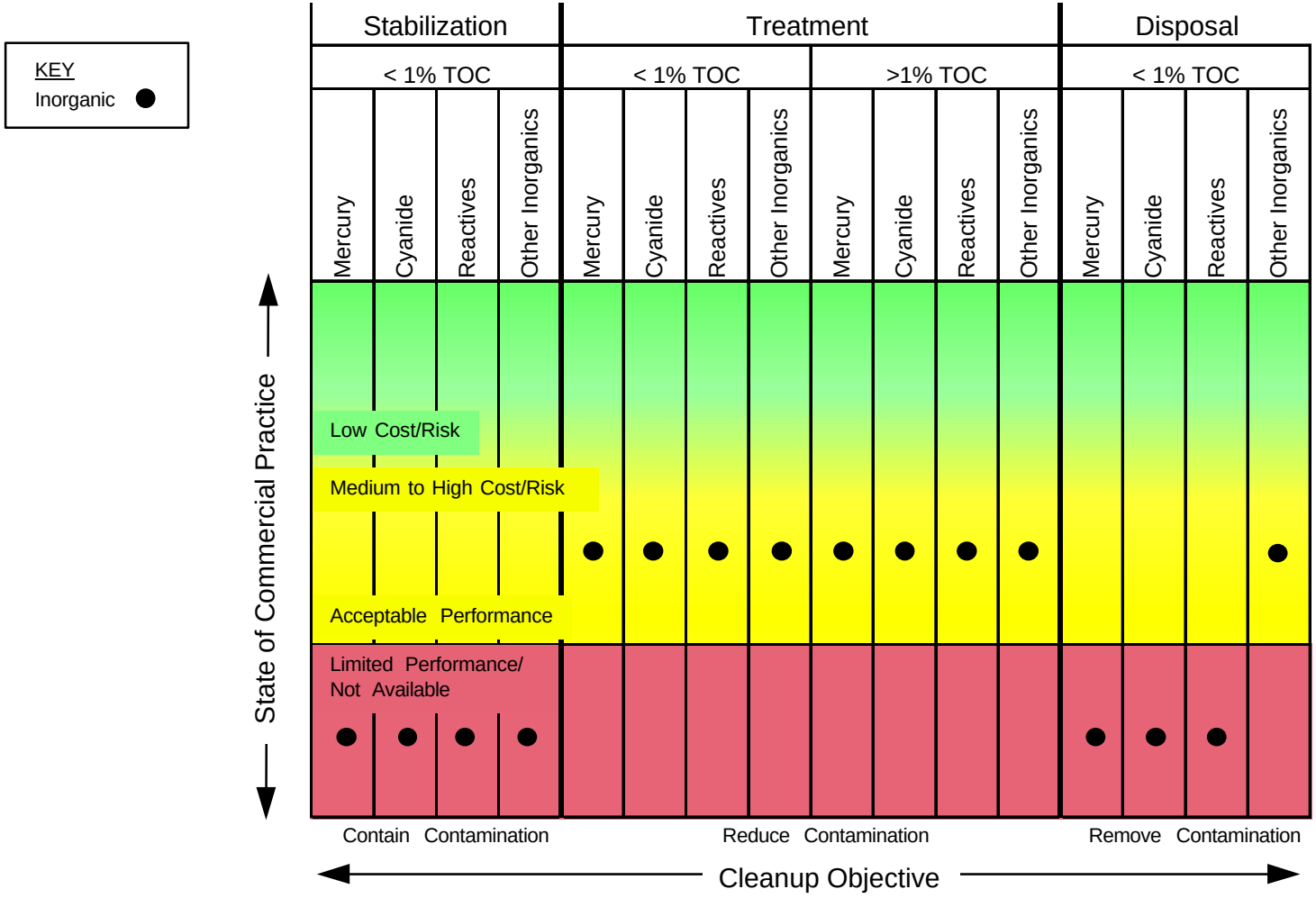
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT. AND COMBUSTIBLES



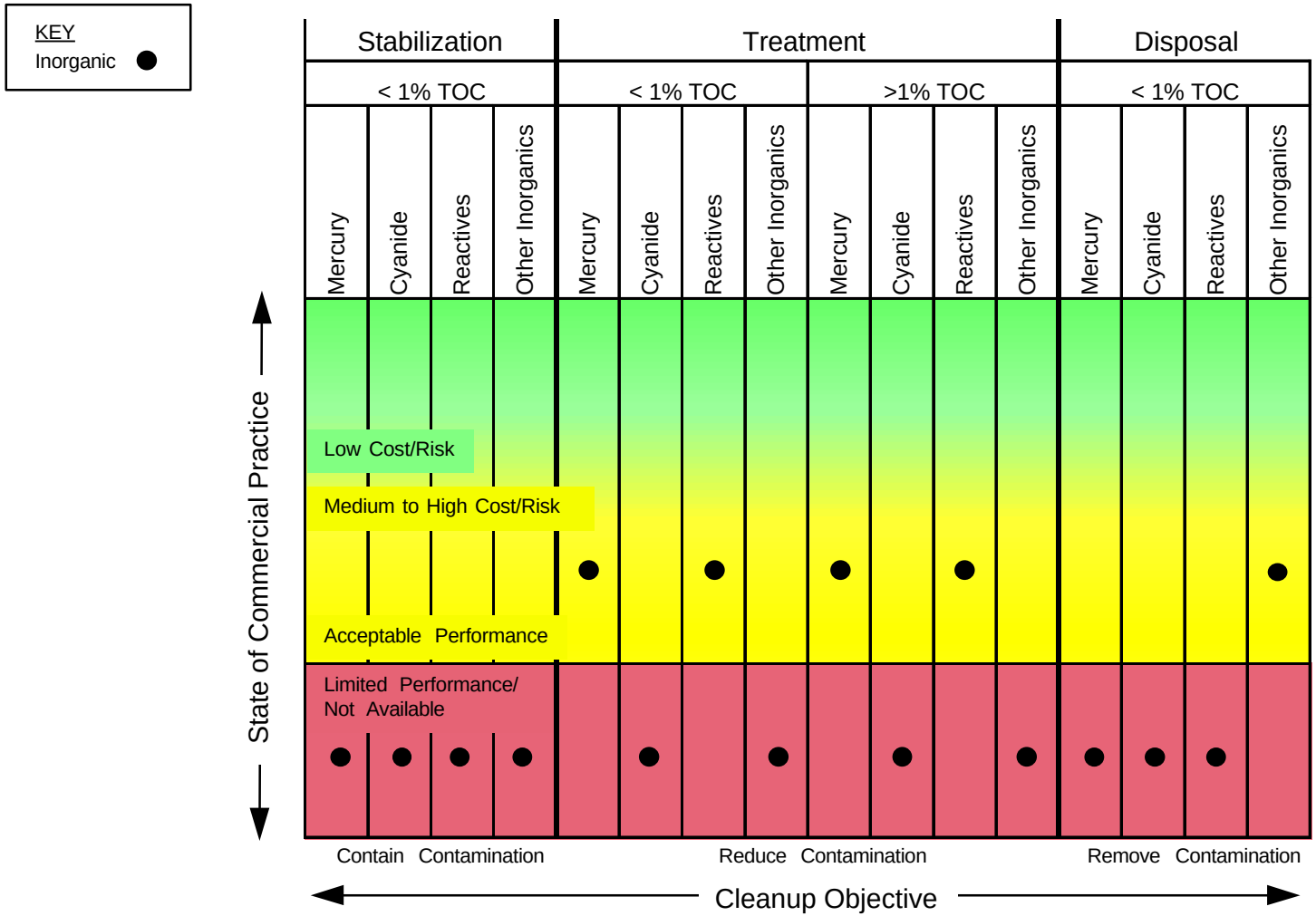
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT. AND LEAD BRICKS



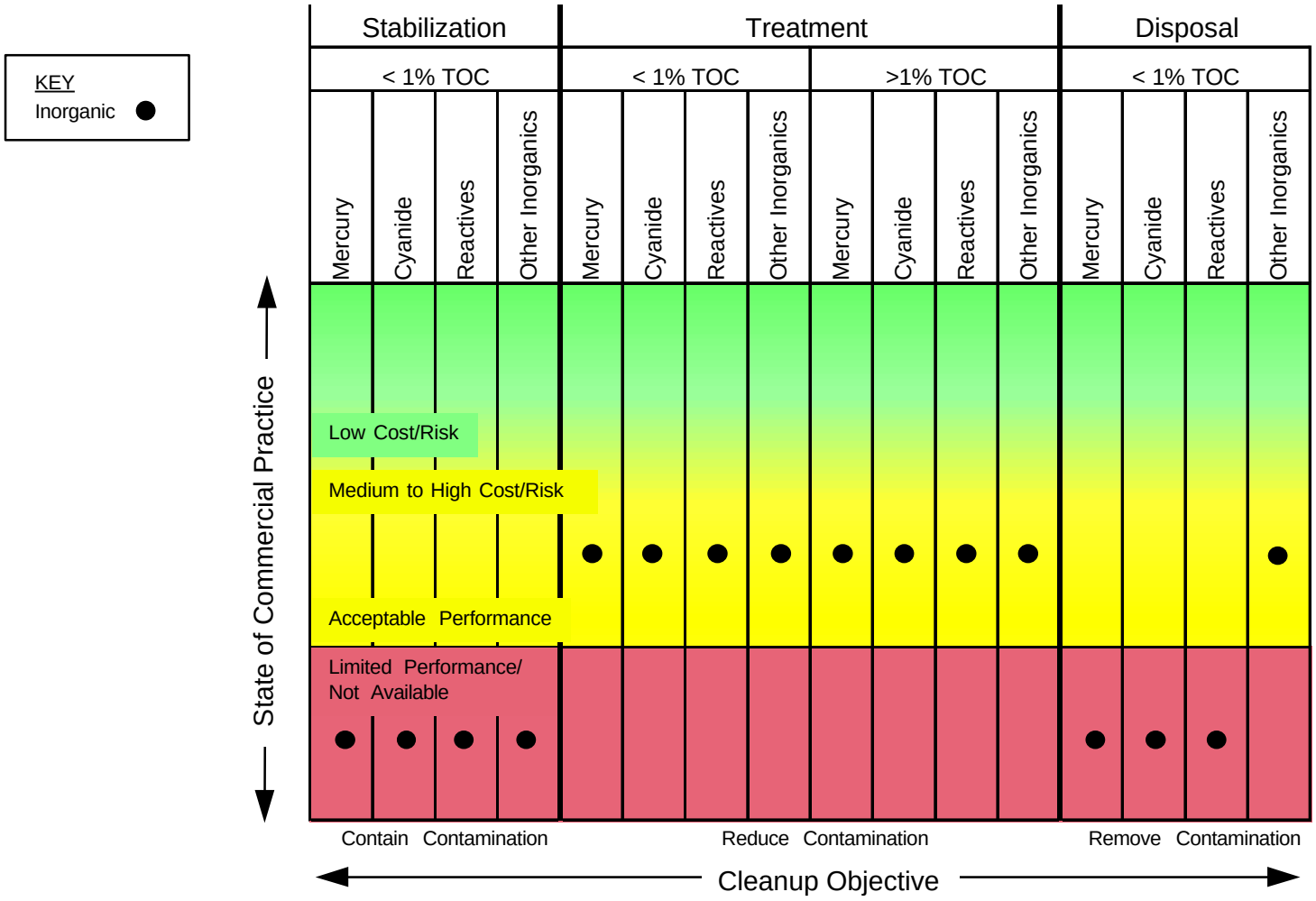
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT. AND DISCERNABLE ENERGETICS



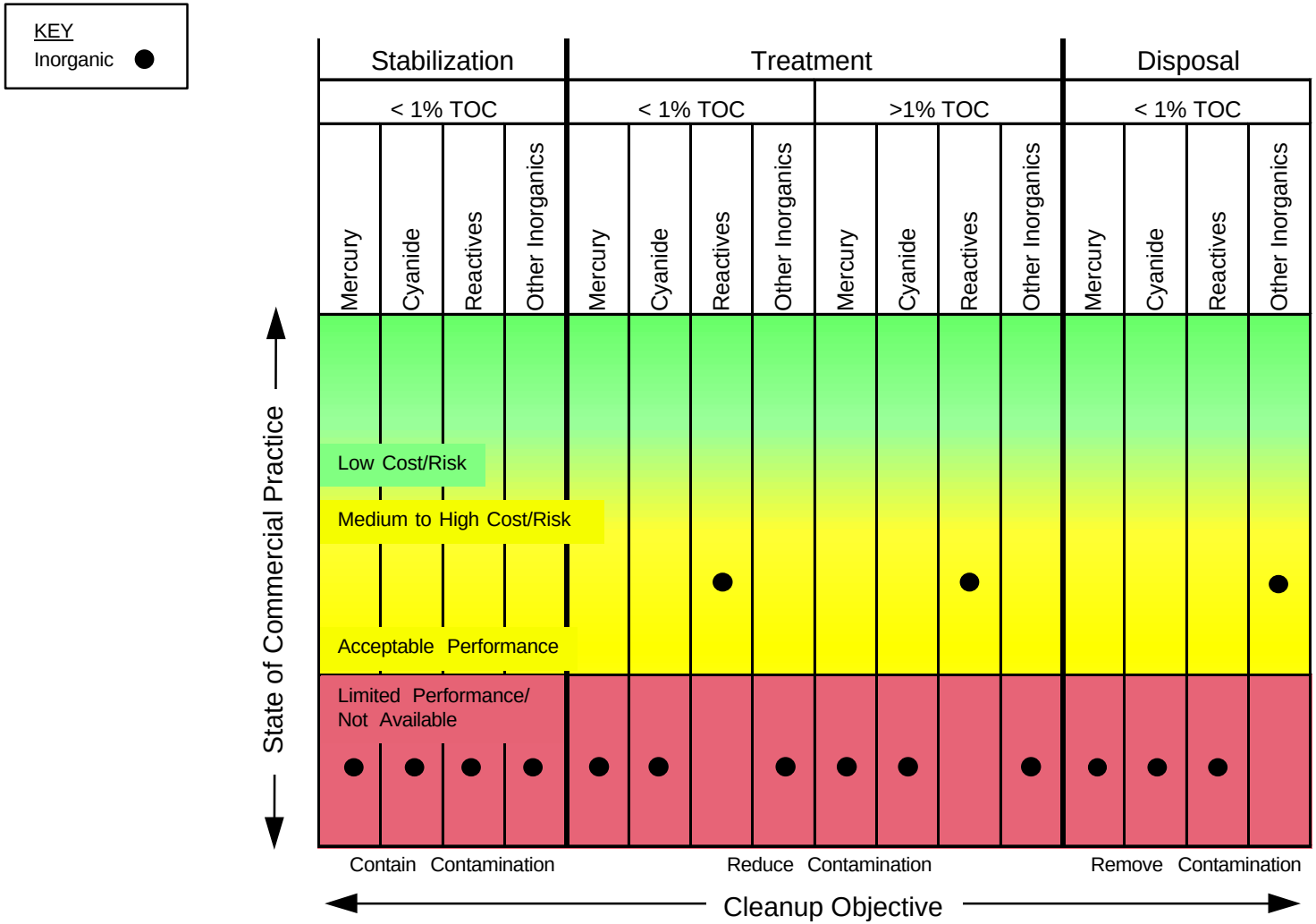
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH COMBUSTIBLES AND LEAD BRICKS



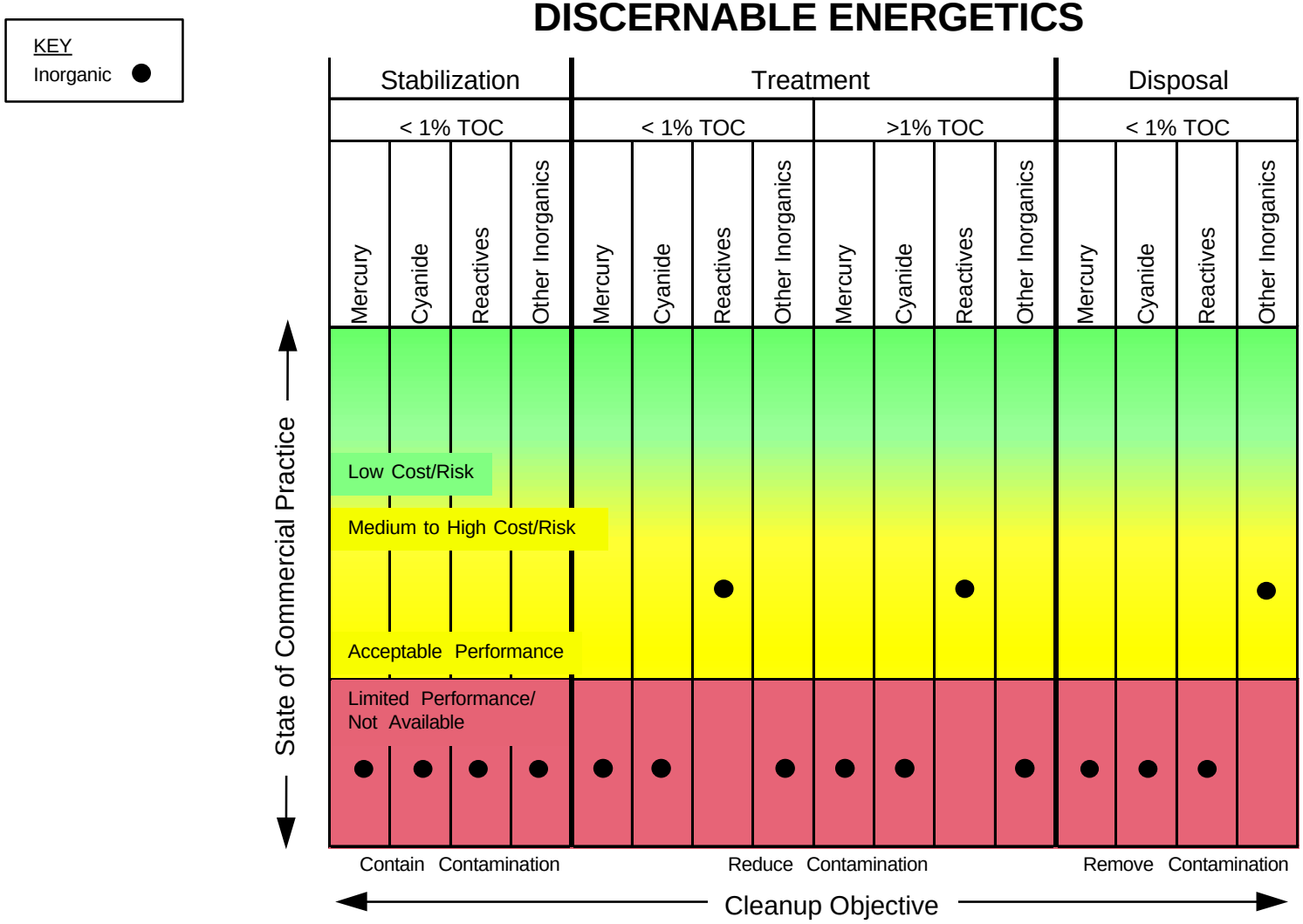
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH COMBUSTIBLES AND DISCERNABLE ENERGETICS



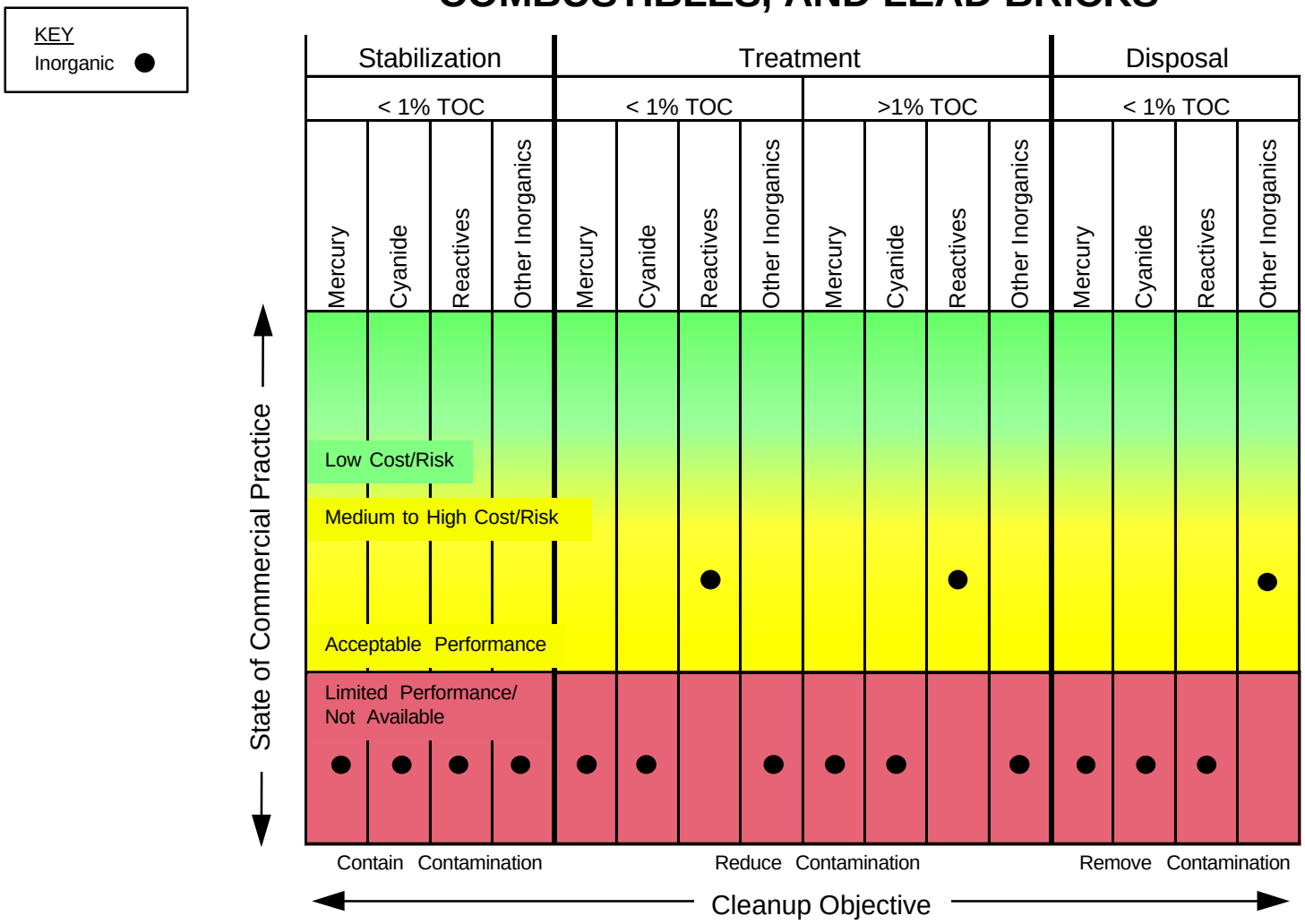
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH LEAD BRICKS AND DISCERNABLE ENERGETICS



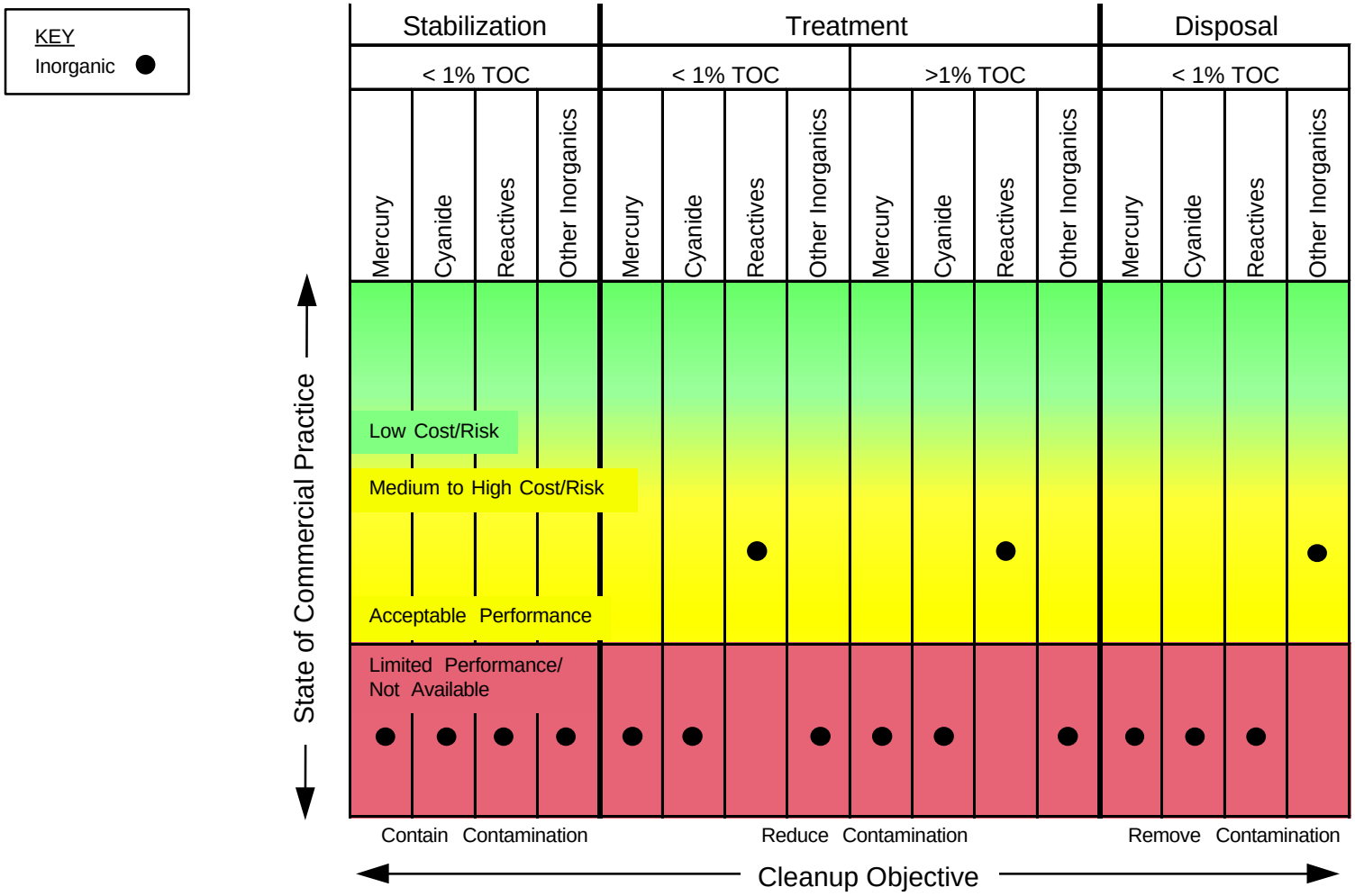
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT., COMBUSTIBLES, AND LEAD BRICKS



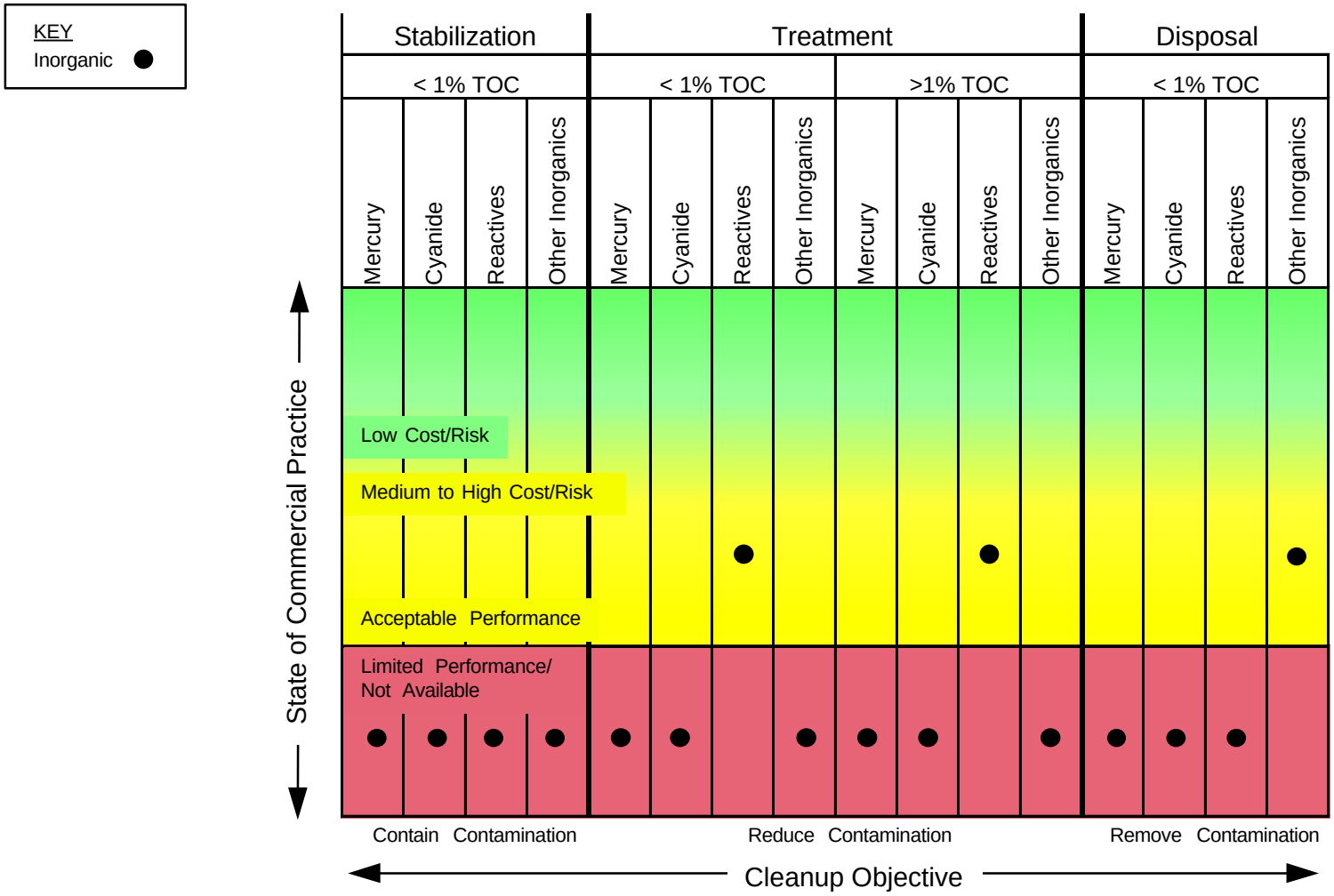
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



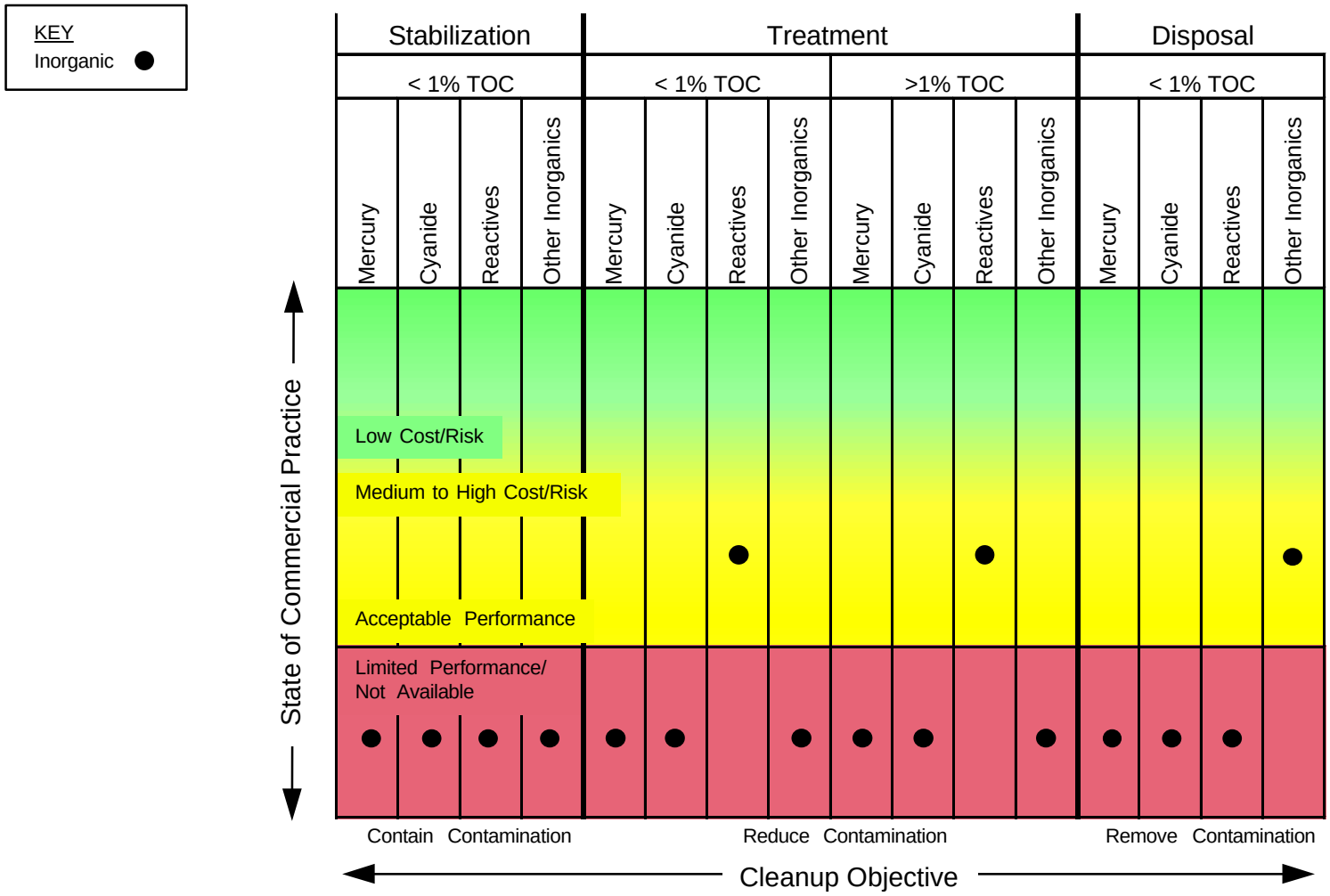
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH SIZE >1FT., LEAD BRICKS, AND DISCERNABLE ENERGETICS



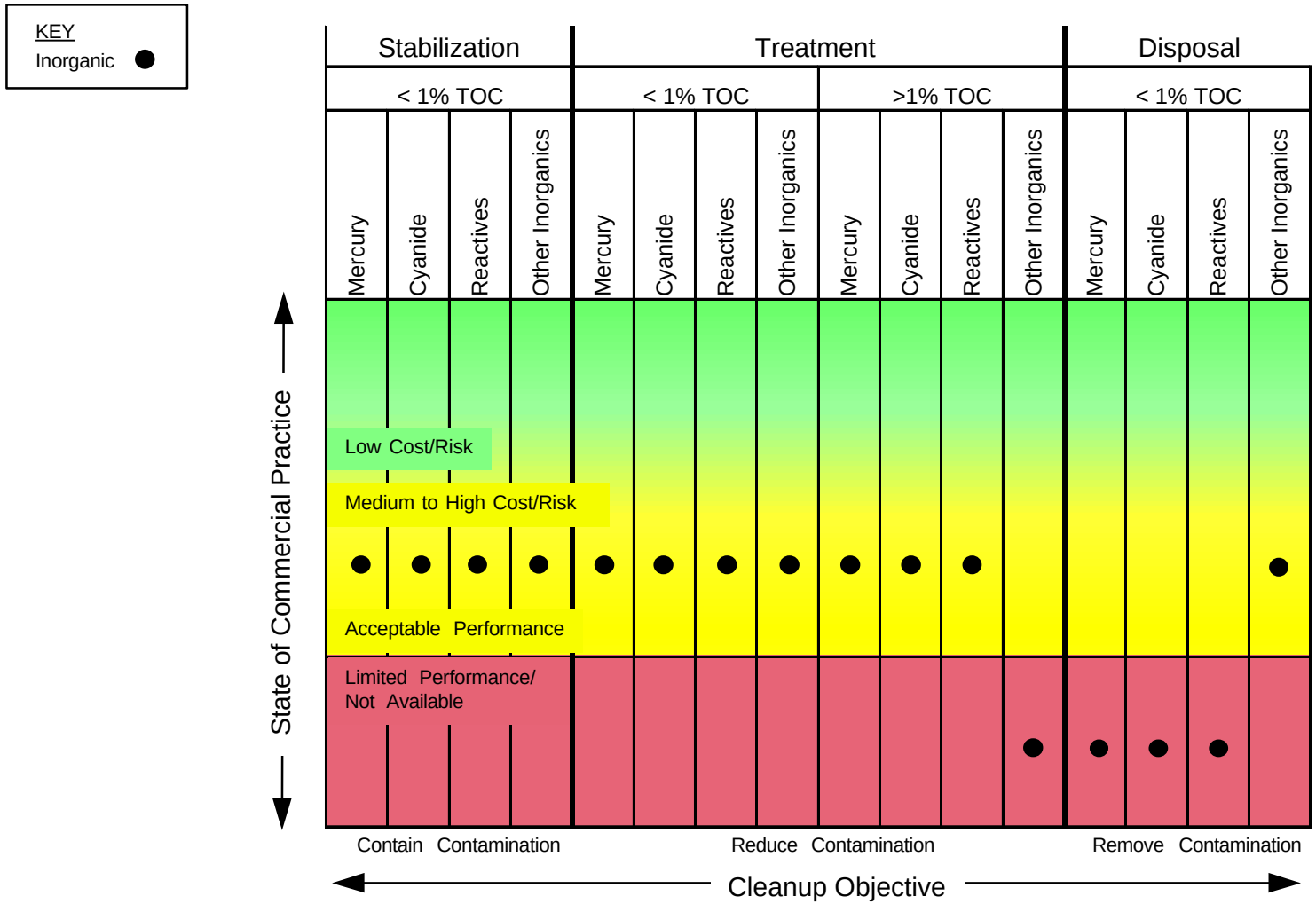
Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC WITH COMBUSTIBLES, LEAD BRICKS AND DISCERNABLE ENERGETICS



Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - INORGANIC IN ALL OTHER CONDITIONS



Note: Refers to Tables 54 and 56 of the Remediation/Waste Processing PAM

STABILIZATION, TREATMENT, AND DISPOSAL OF SOLIDS/DEBRIS - INORGANIC

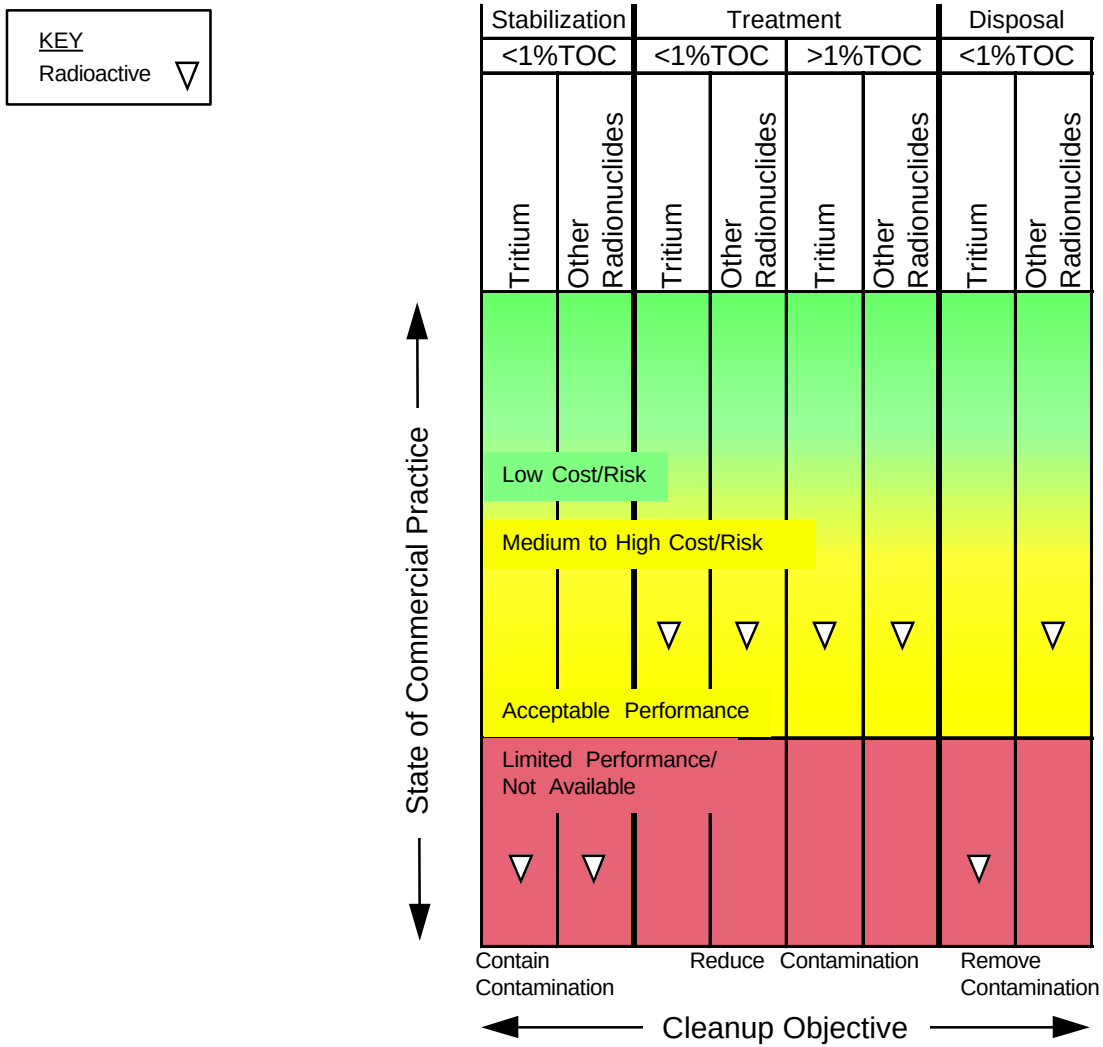
- Good-performance, low-cost/risk stabilization technologies are lacking for all of the high-level conditions considered; where size is less than 1ft. and no combustibles, lead bricks, or discernable energetics are present, improvements are necessary as inorganic encapsulation is the only good-performance, low-cost/risk alternative.

- Improvement is needed to treatment in almost all conditions considered; there are numerous alternatives, but few are highly rated due to performance, cost, and/or risk considerations.

- Generally, commercial practice is completely lacking for treatment if discernable energetics are present.

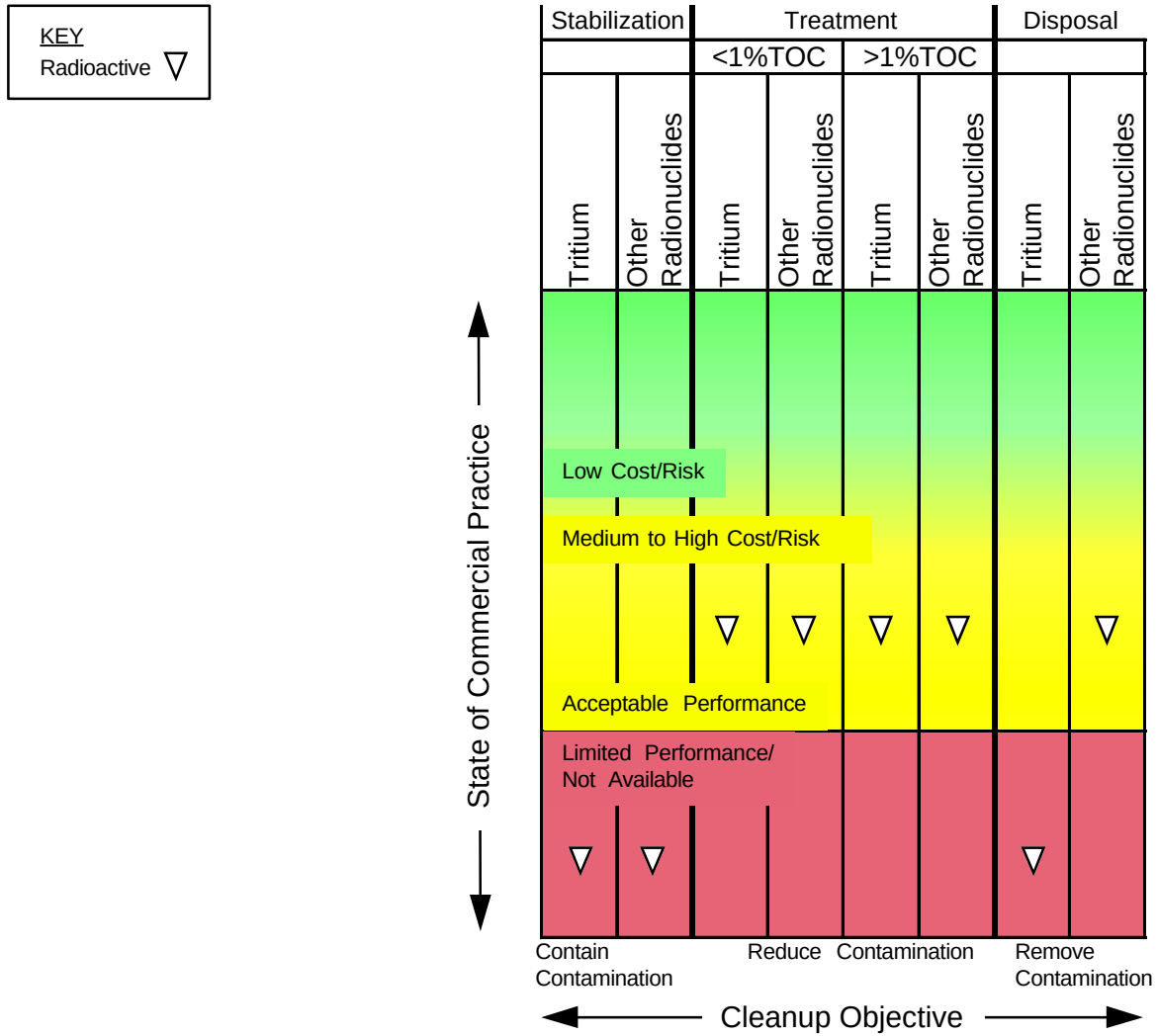
- Disposal practices are absent if mercury, cyanide, or reactives are present due to regulatory considerations; otherwise, inorganic contaminated solids/debris can be disposed of at medium- to high-cost/risk in a RCRA landfill.

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1 FT.



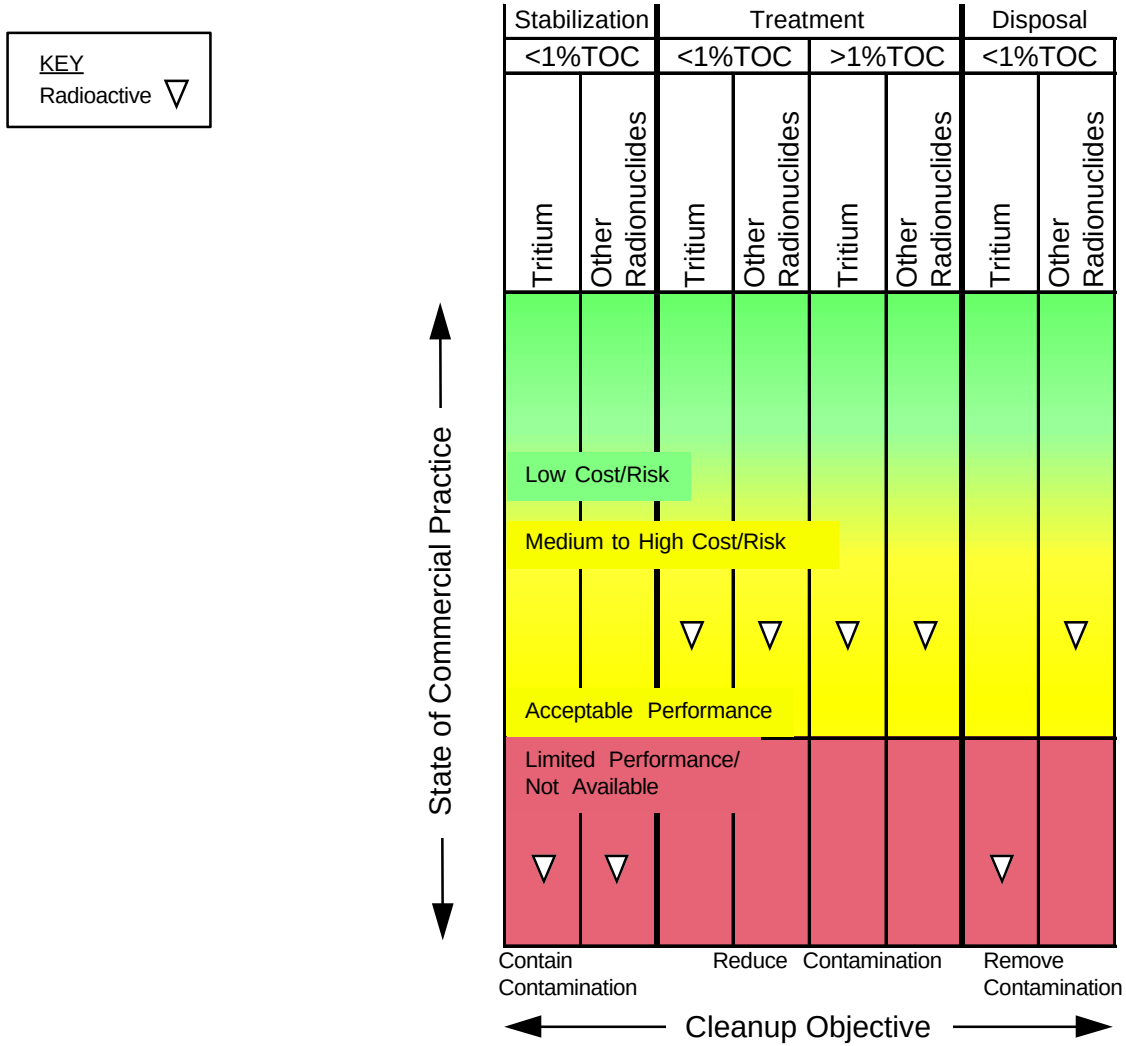
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH COMBUSTIBLES



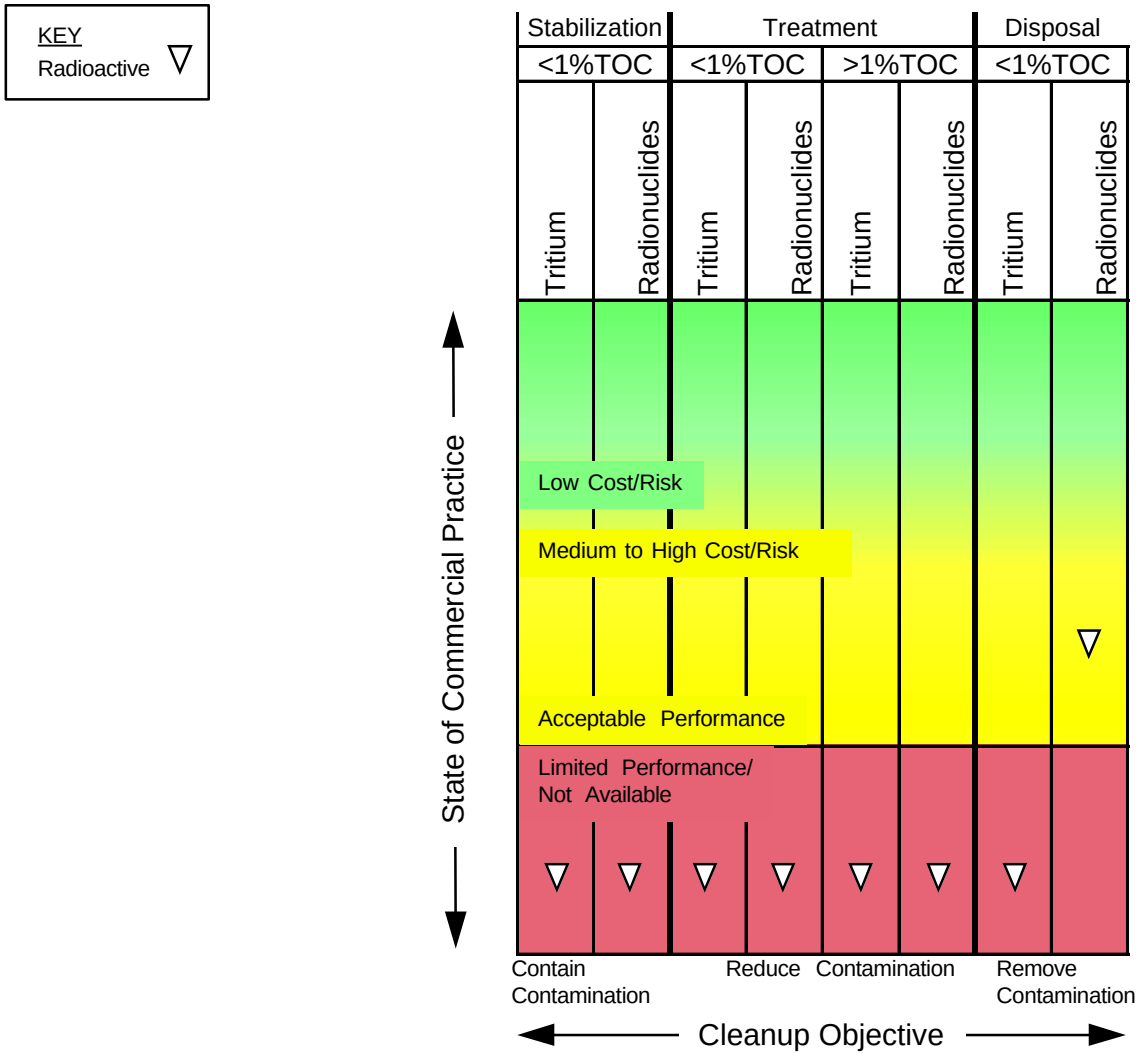
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH LEAD BRICKS



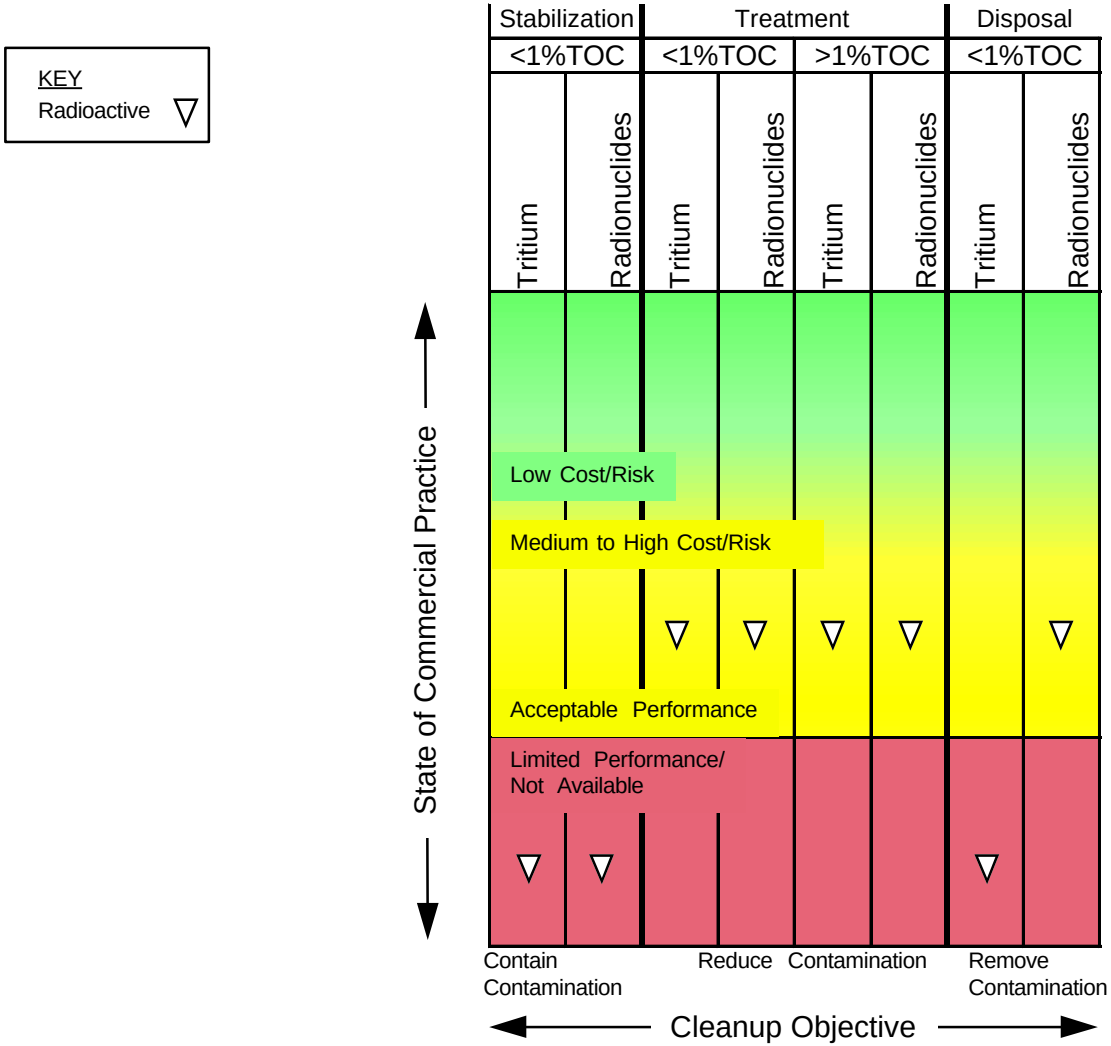
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH DISCERNABLE ENERGETICS



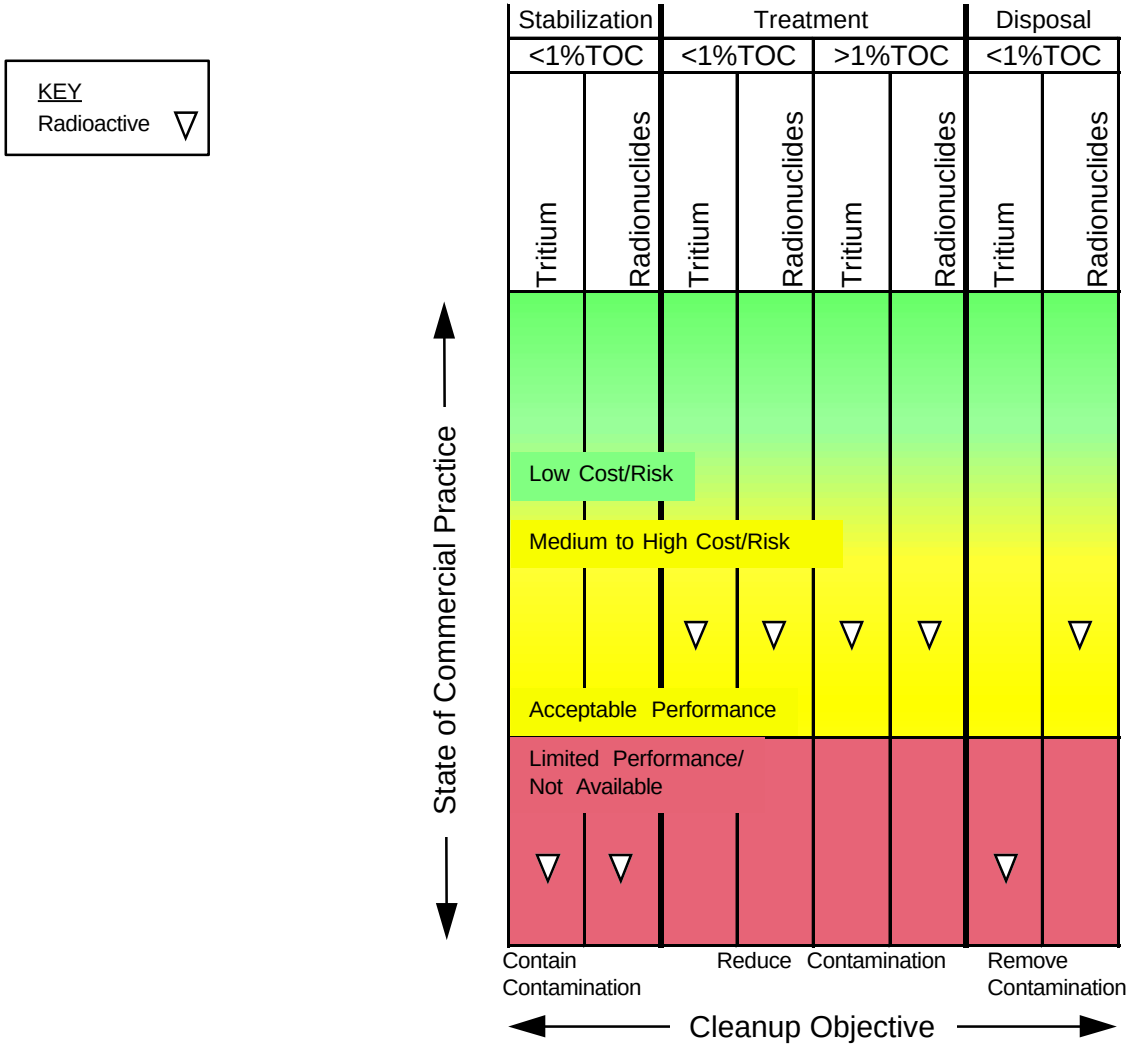
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1 FT. AND COMBUSTIBLES



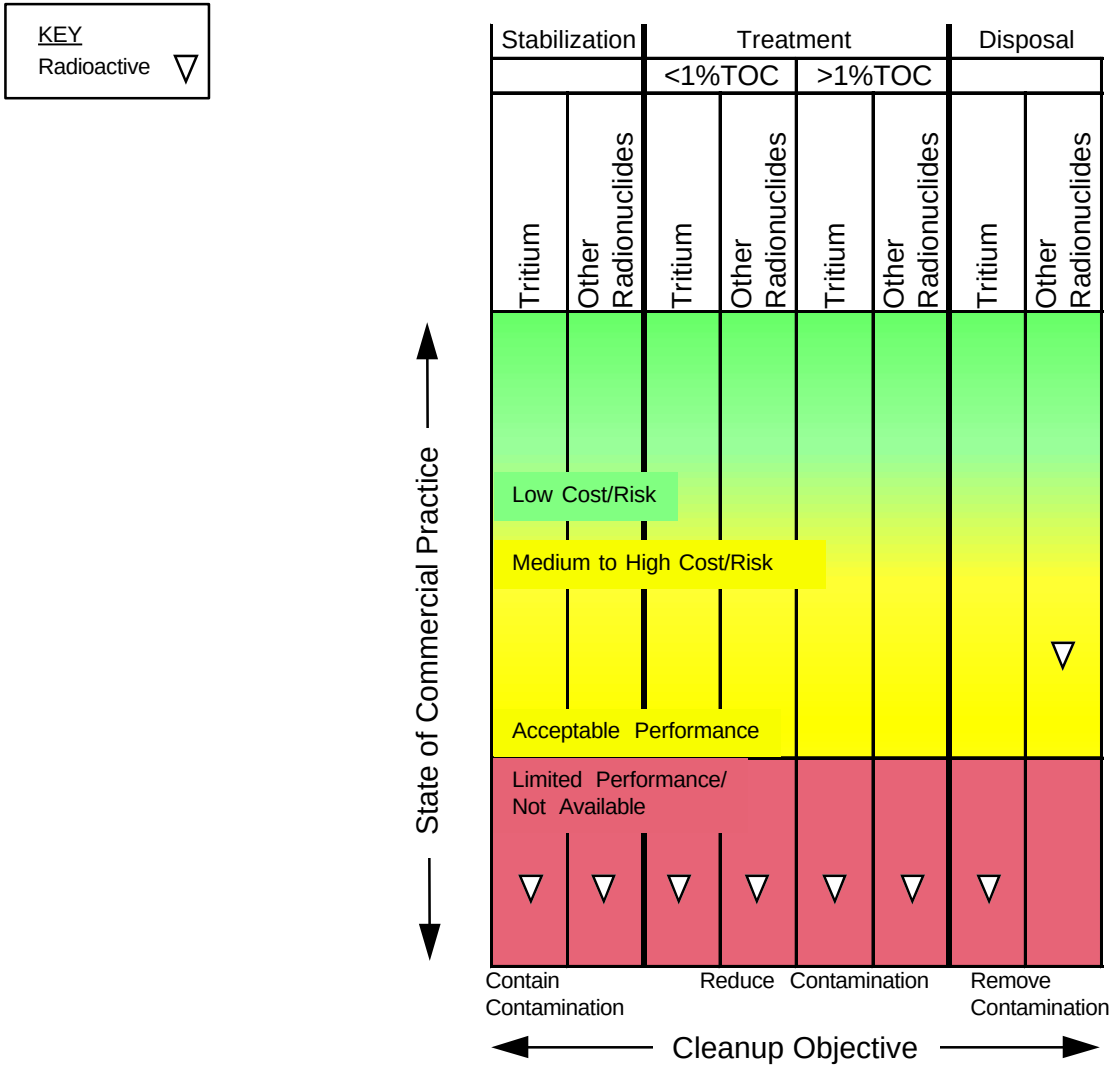
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1 FT. AND LEAD BRICKS



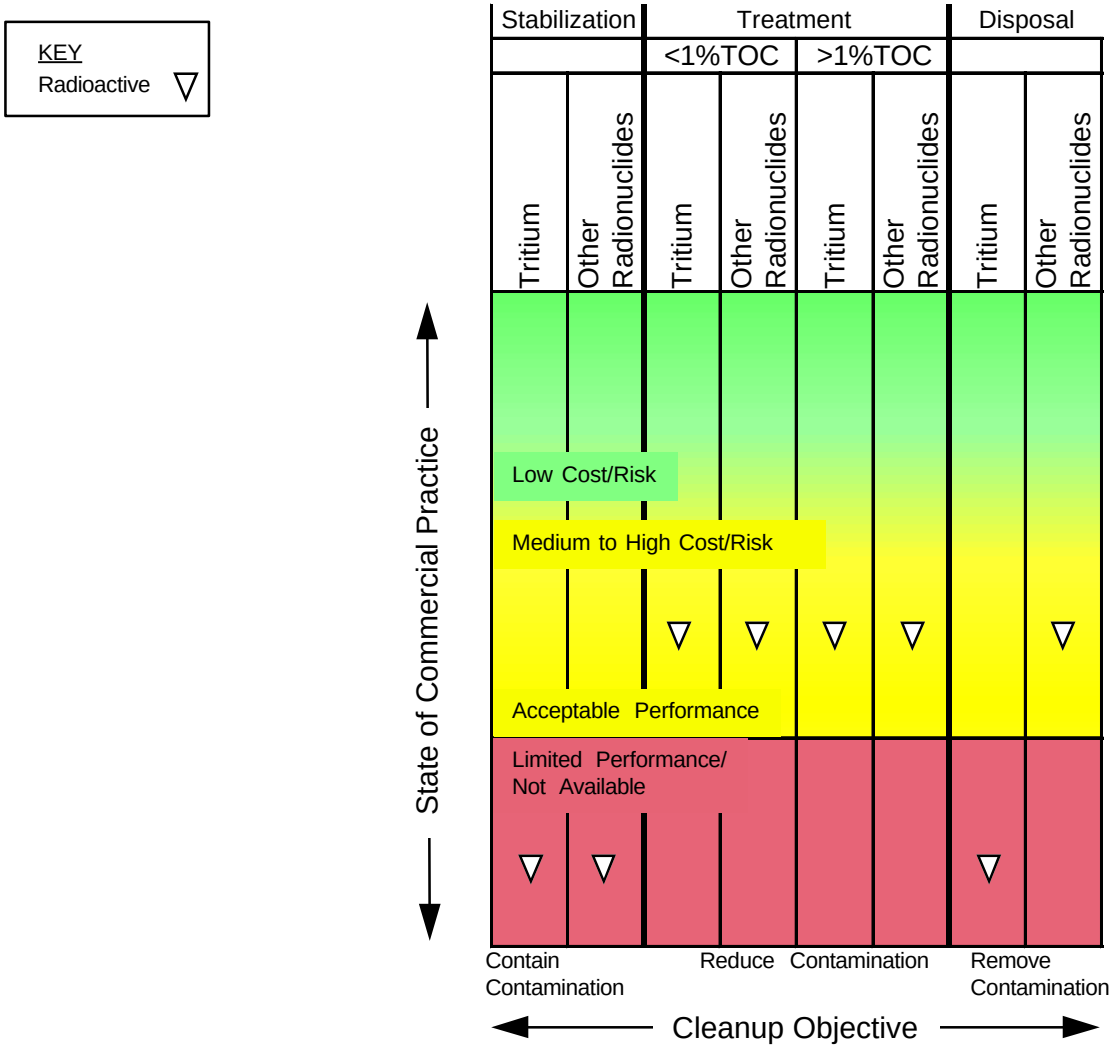
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1 FT. AND DISCERNABLE ENERGETICS



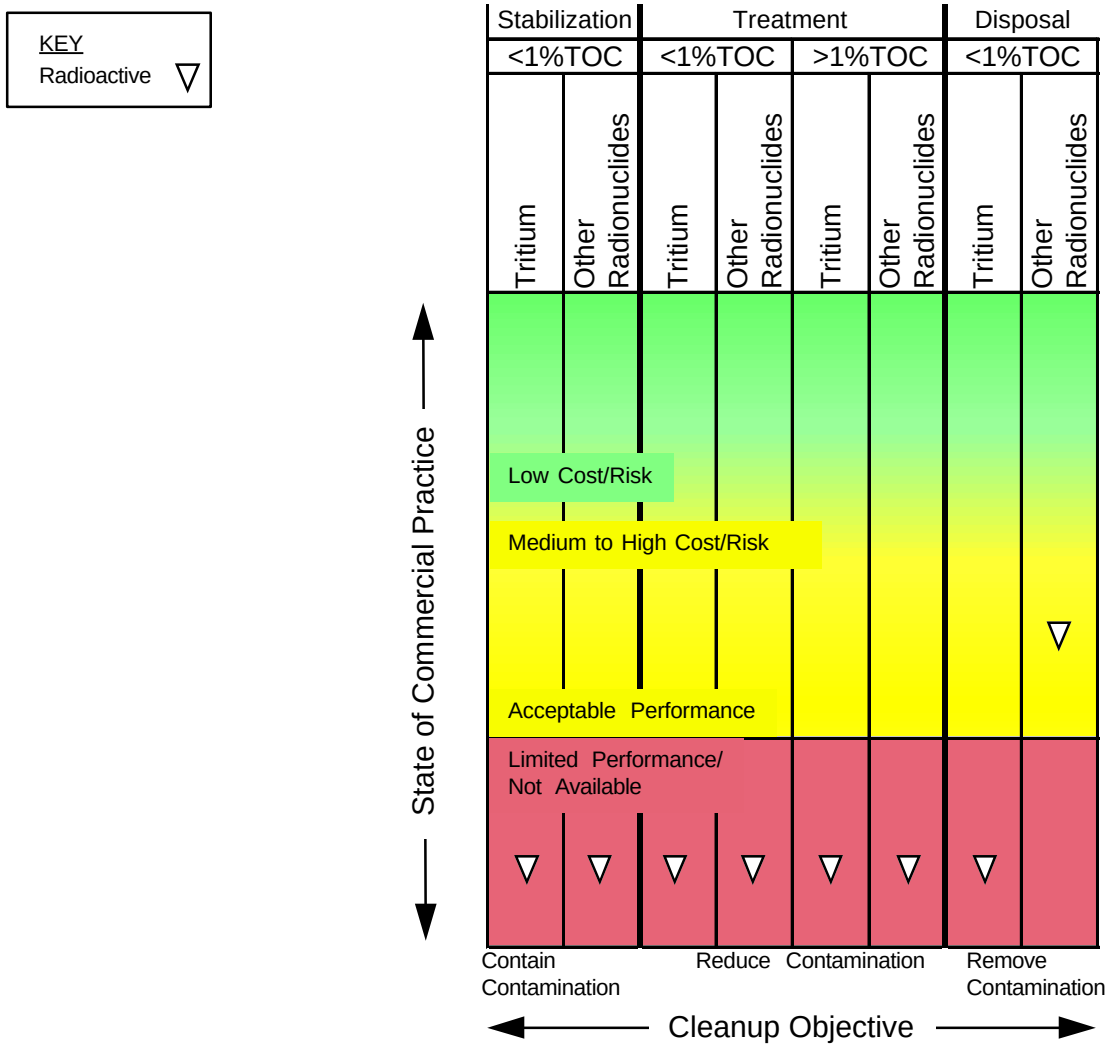
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH COMBUSTIBLES AND LEAD BRICKS



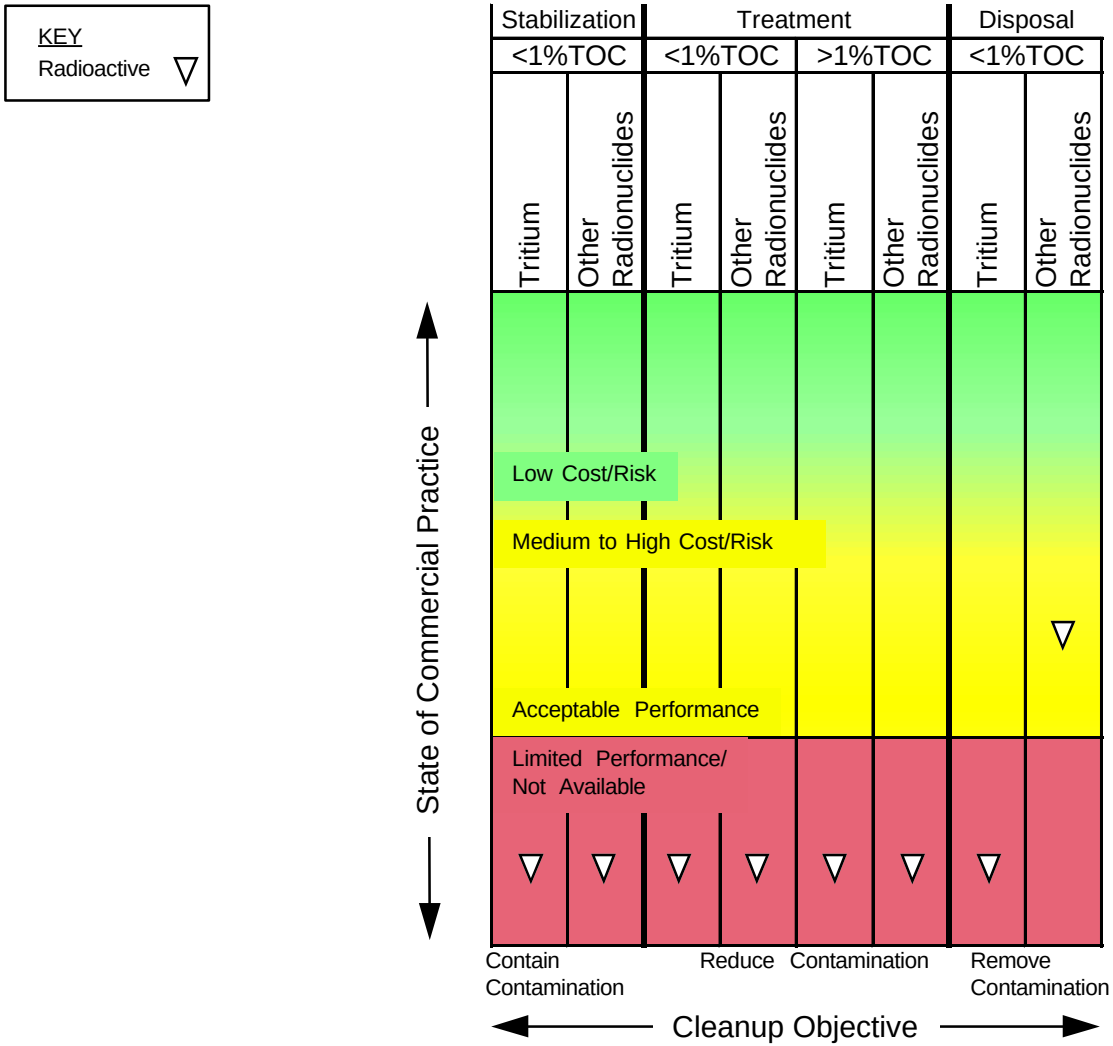
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH COMBUSTIBLES AND DISCERNABLE ENERGETICS



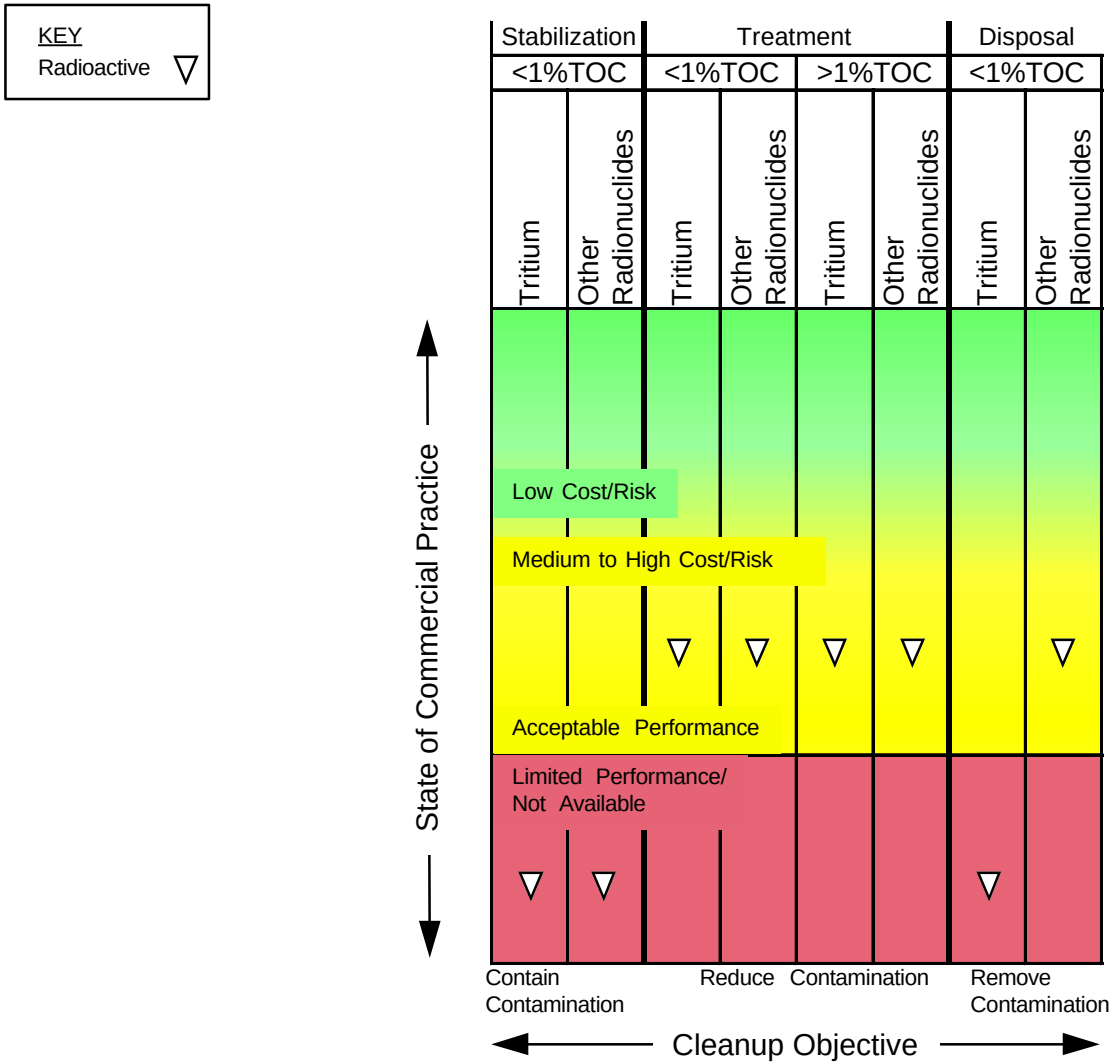
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH LEAD BRICKS AND DISCERNABLE ENERGETICS



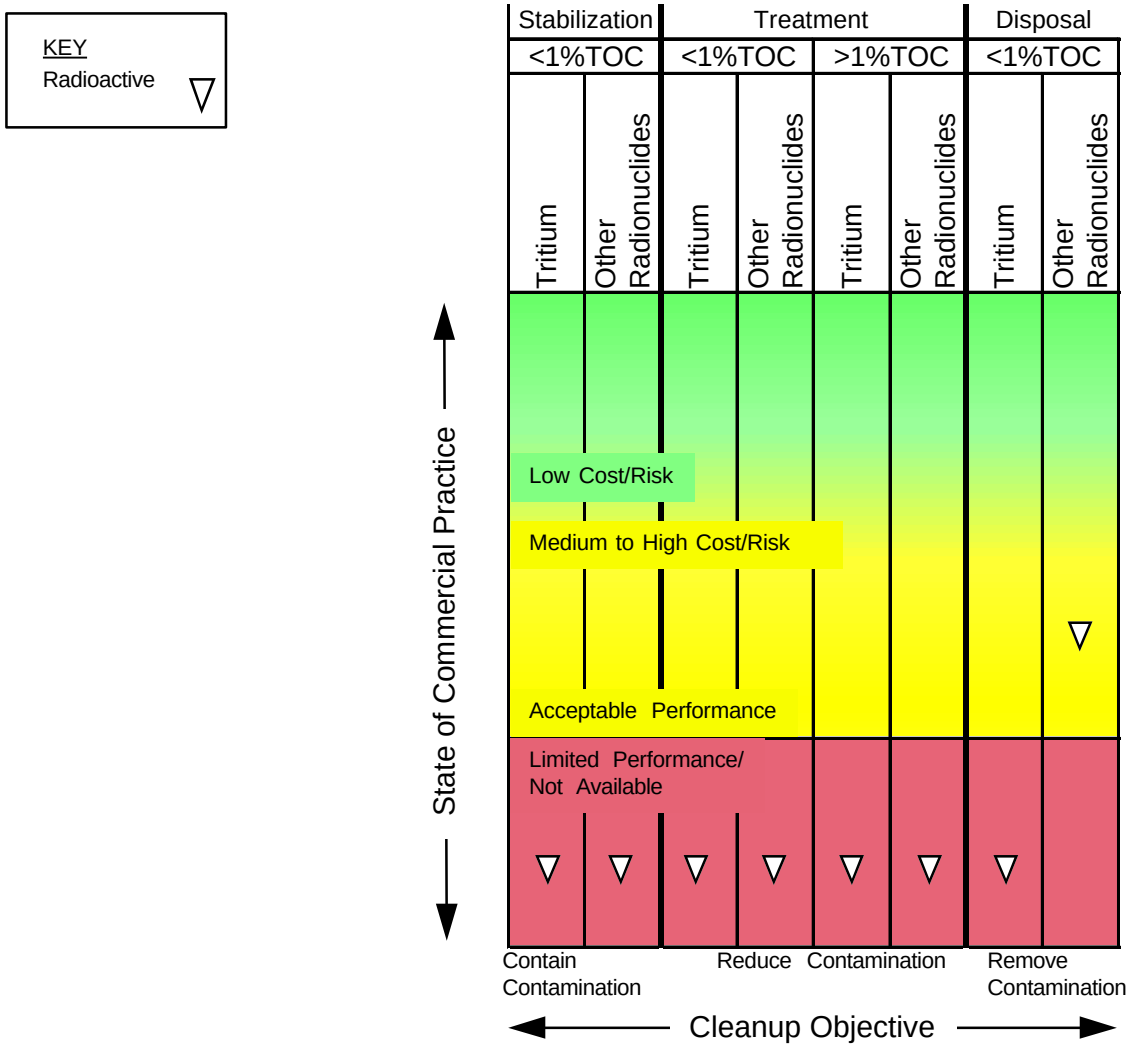
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1FT., COMBUSTIBLES, AND LEAD BRICKS



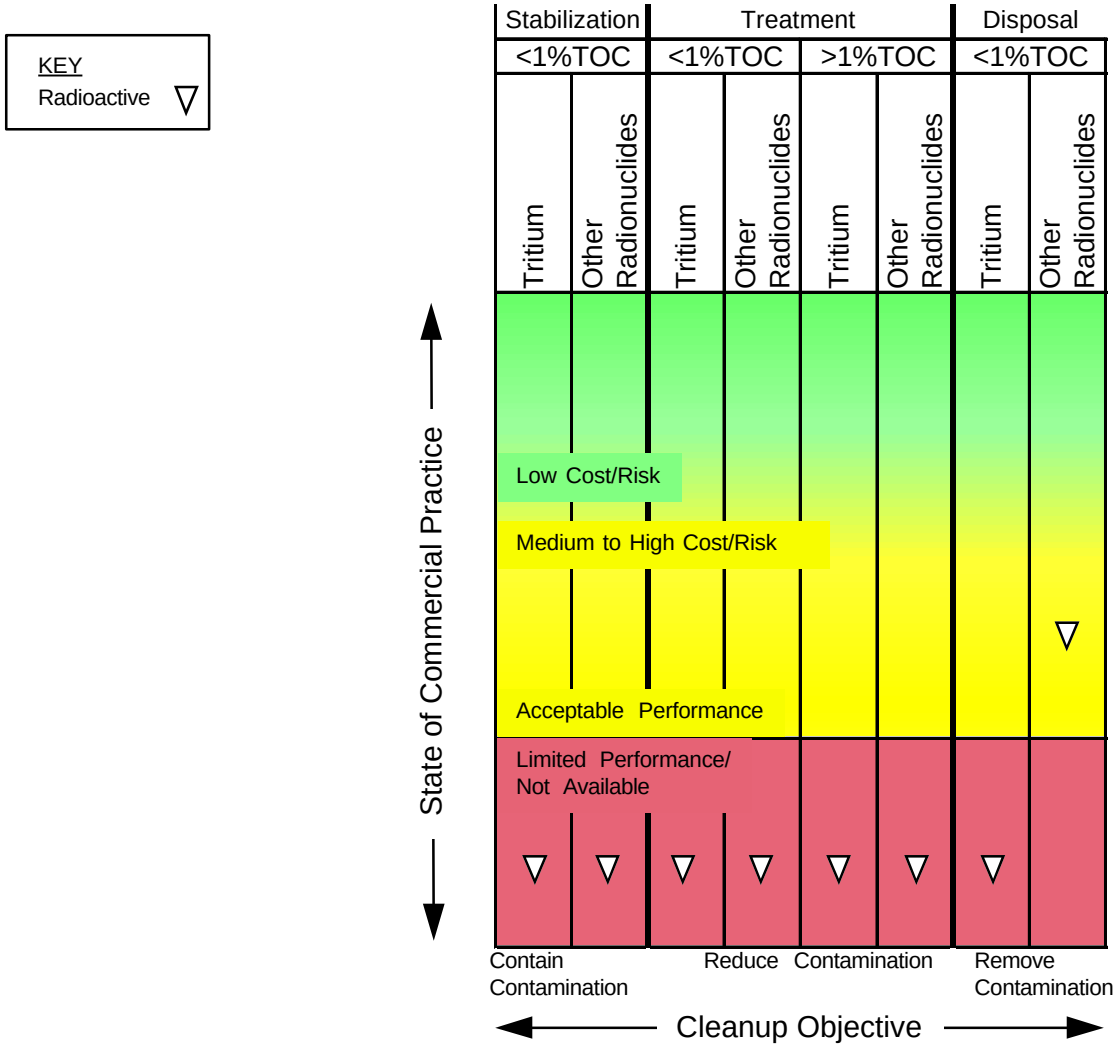
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



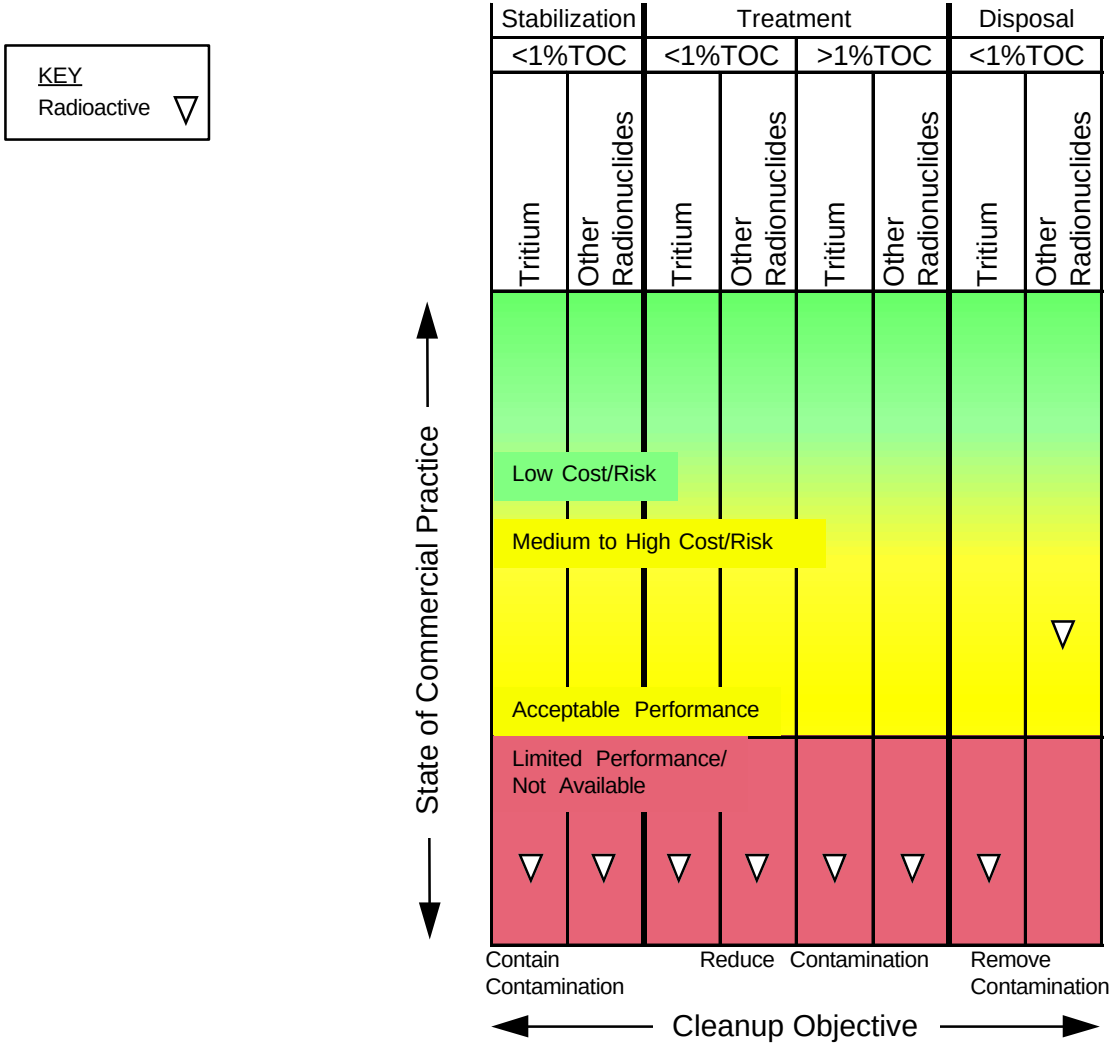
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH SIZE >1FT., LEAD BRICKS, AND DISCERNABLE ENERGETICS



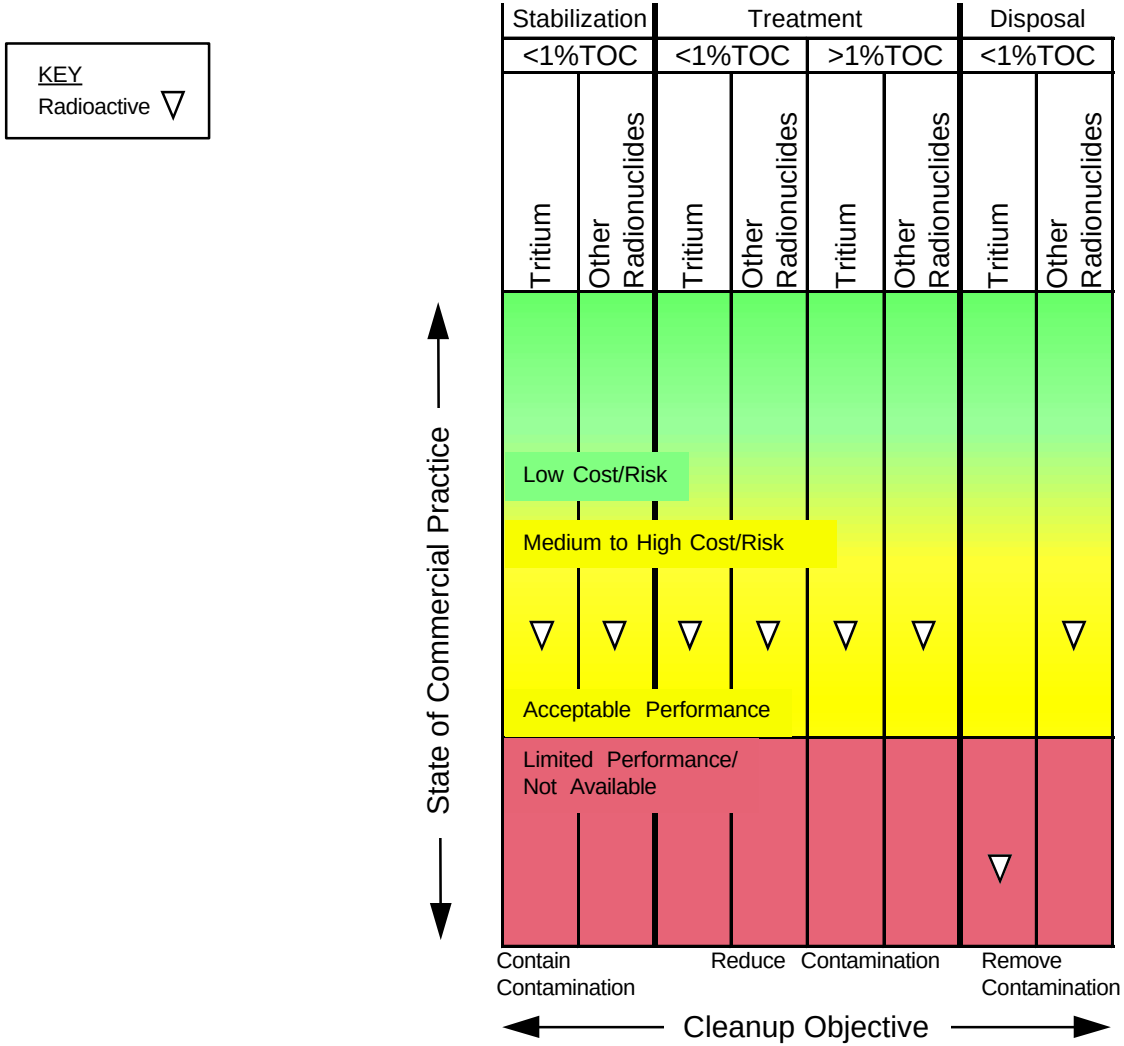
Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE WITH COMBUSTIBLES, LEAD BRICKS, AND DISCERNABLE ENERGETICS



Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - RADIOACTIVE IN ALL OTHER CONDITIONS



Note: Refers to Tables 54 and 57 of the Remediation/Waste Processing PAM

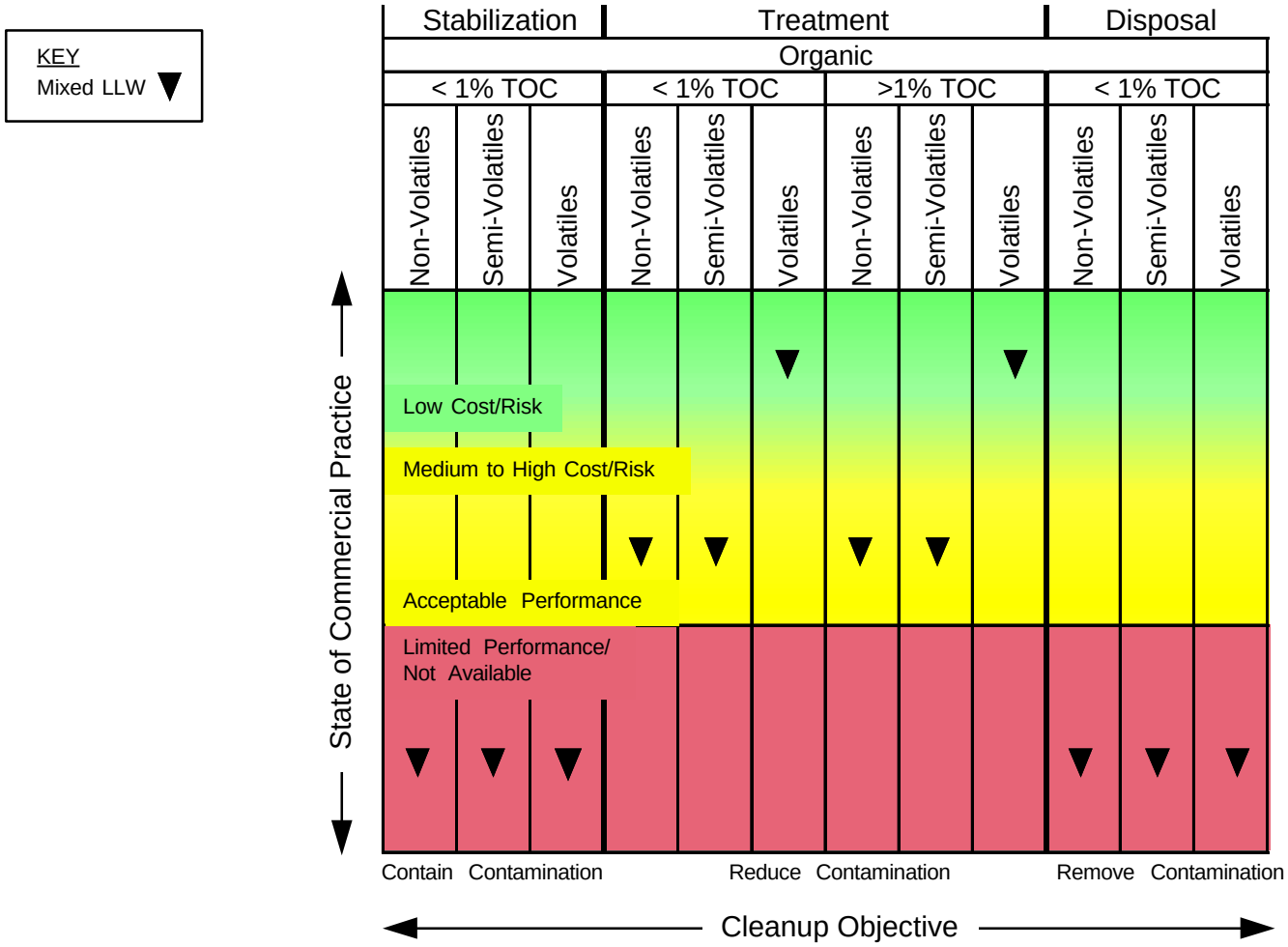
STABILIZATION, TREATMENT, AND DISPOSAL OF SOLIDS/DEBRIS - RADIOACTIVE

- Good-performance, low-cost/risk stabilization technologies are lacking for all of the high-level conditions considered; where size is less than 1ft. and no combustibles, lead bricks, or discernable energetics are present, improvements are necessary as inorganic encapsulation is the only good-performance, low-cost/risk alternative.

- Generally, treatment needs improvement for the conditions considered due to the many alternatives rated average based on performance, cost and/or risk considerations; an exception is that conditions with discernable energetics are lacking commercial practices.

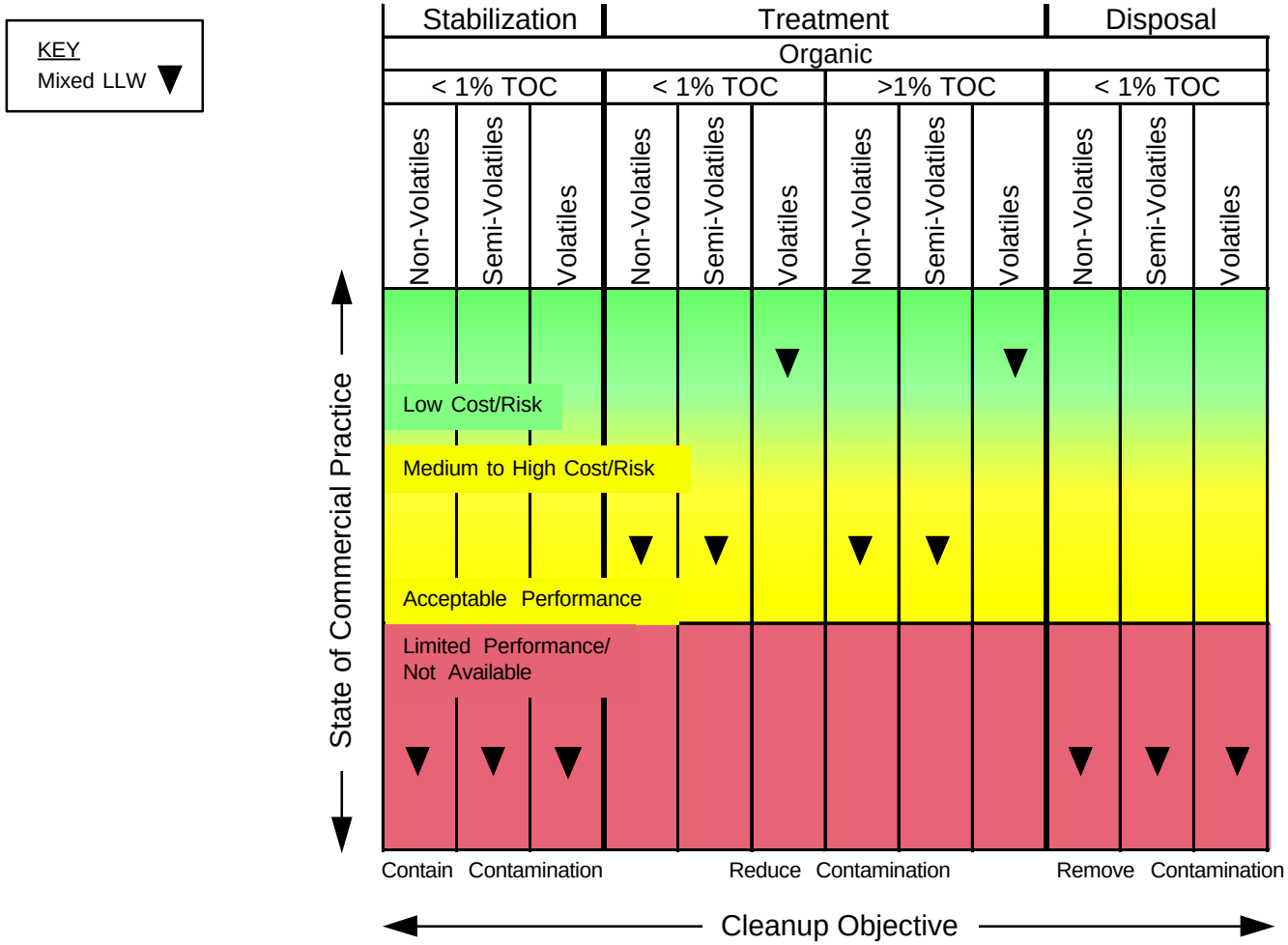
- There are two medium- to high- cost/risk alternatives for disposal of radionuclides where tritium is not present.

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS AND SIZE >1 FT.



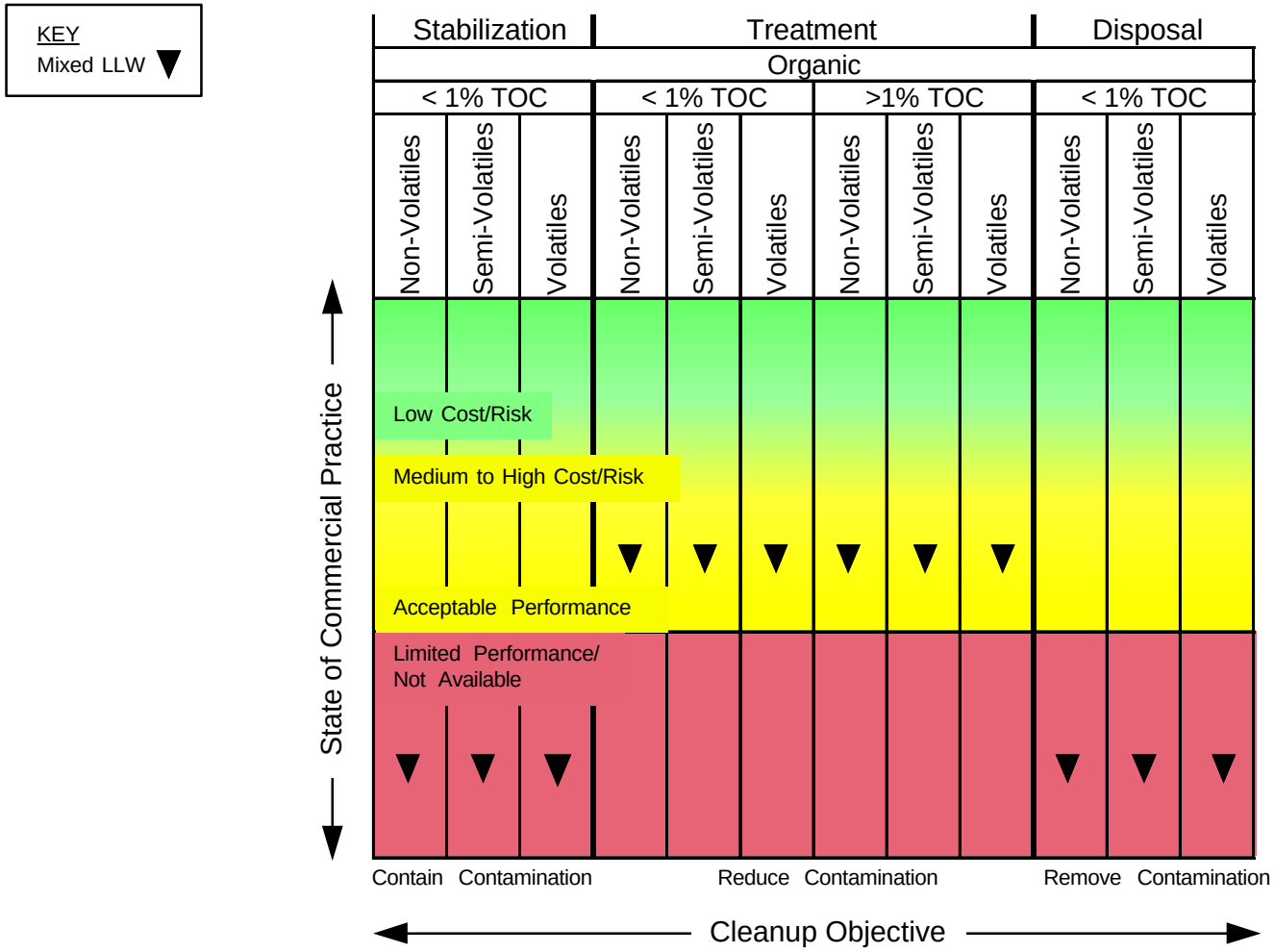
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS AND COMBUSTIBLES



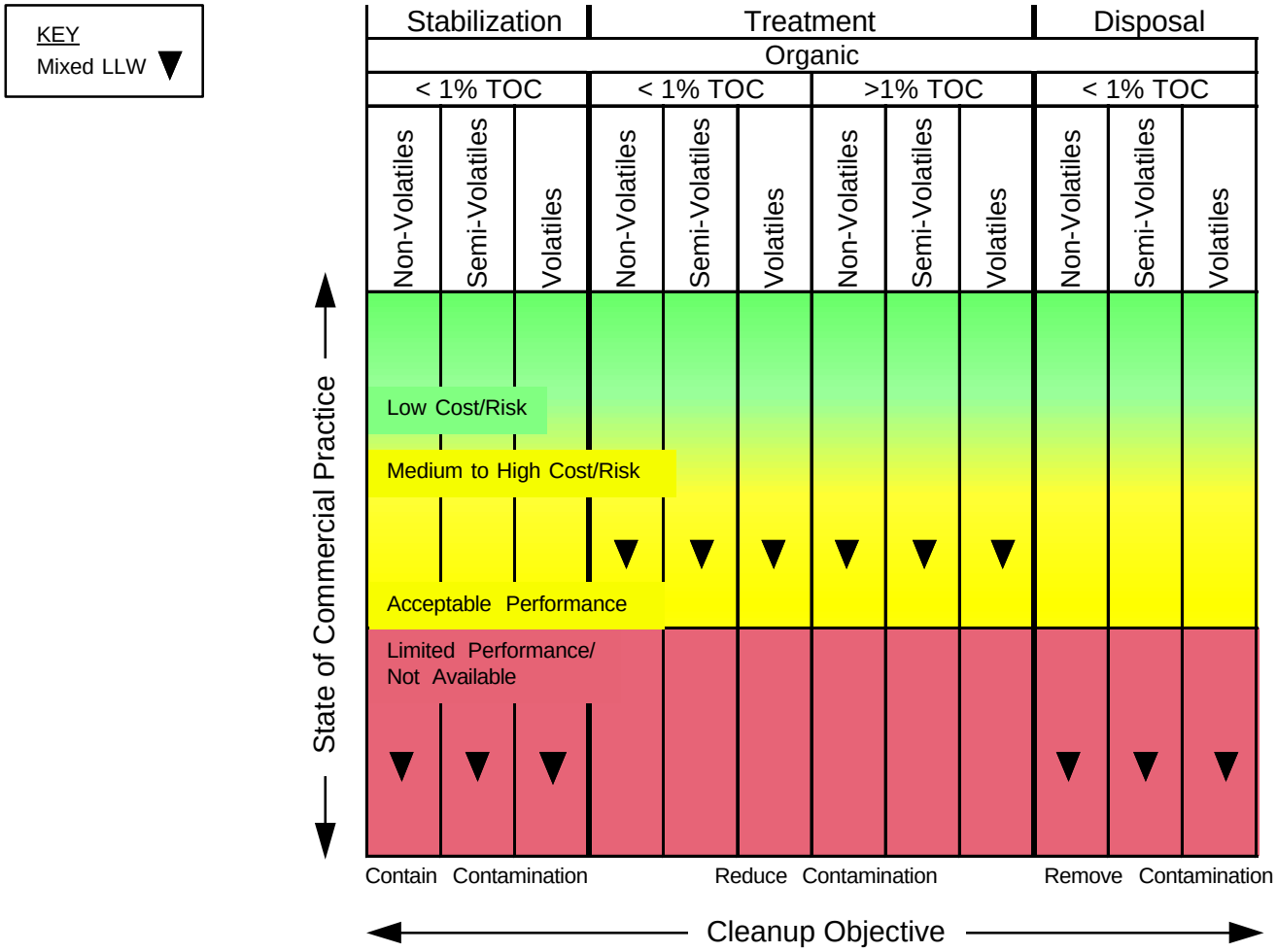
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS AND LEAD BRICKS



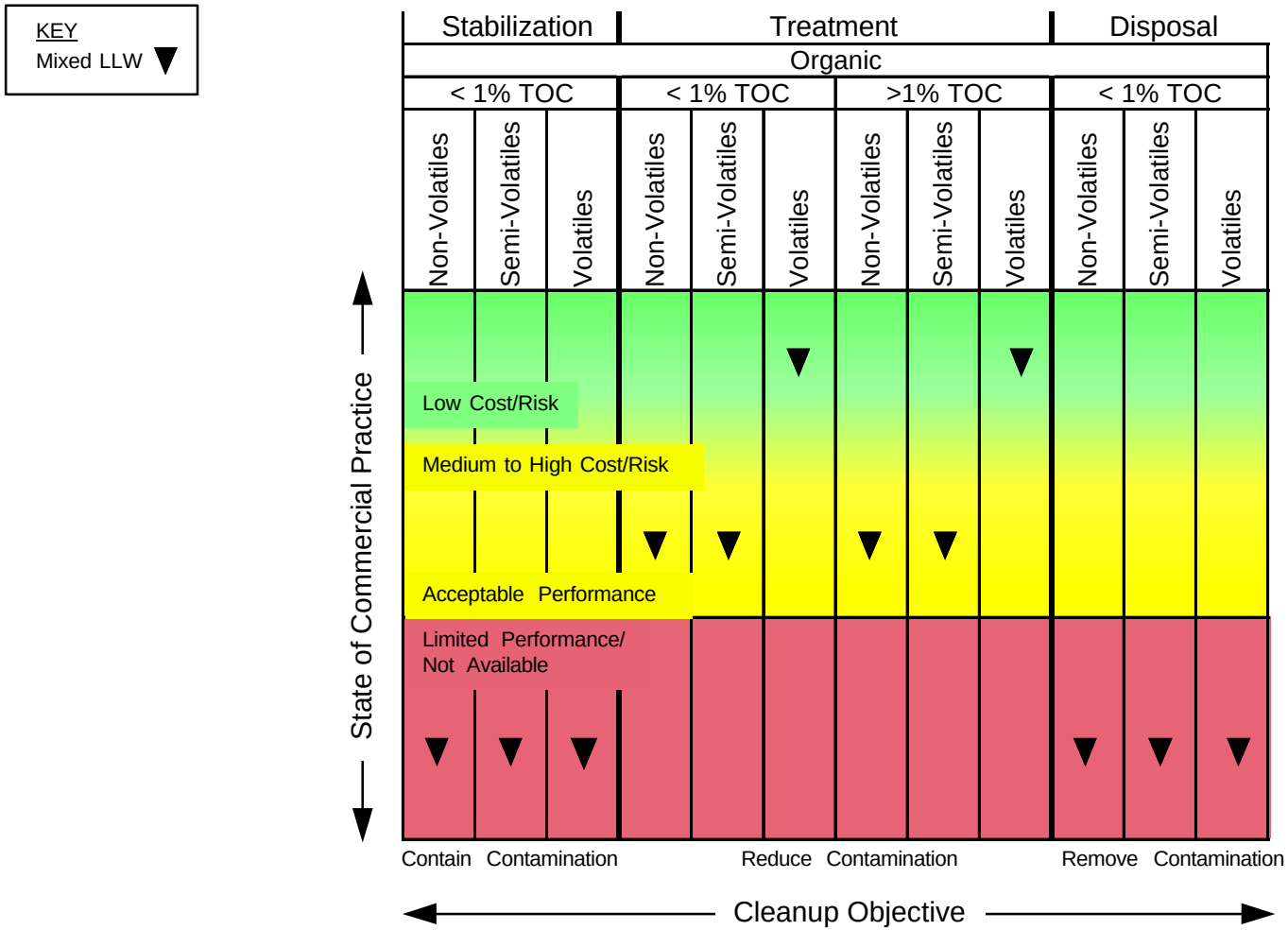
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS AND DISCERNABLE ENERGETICS



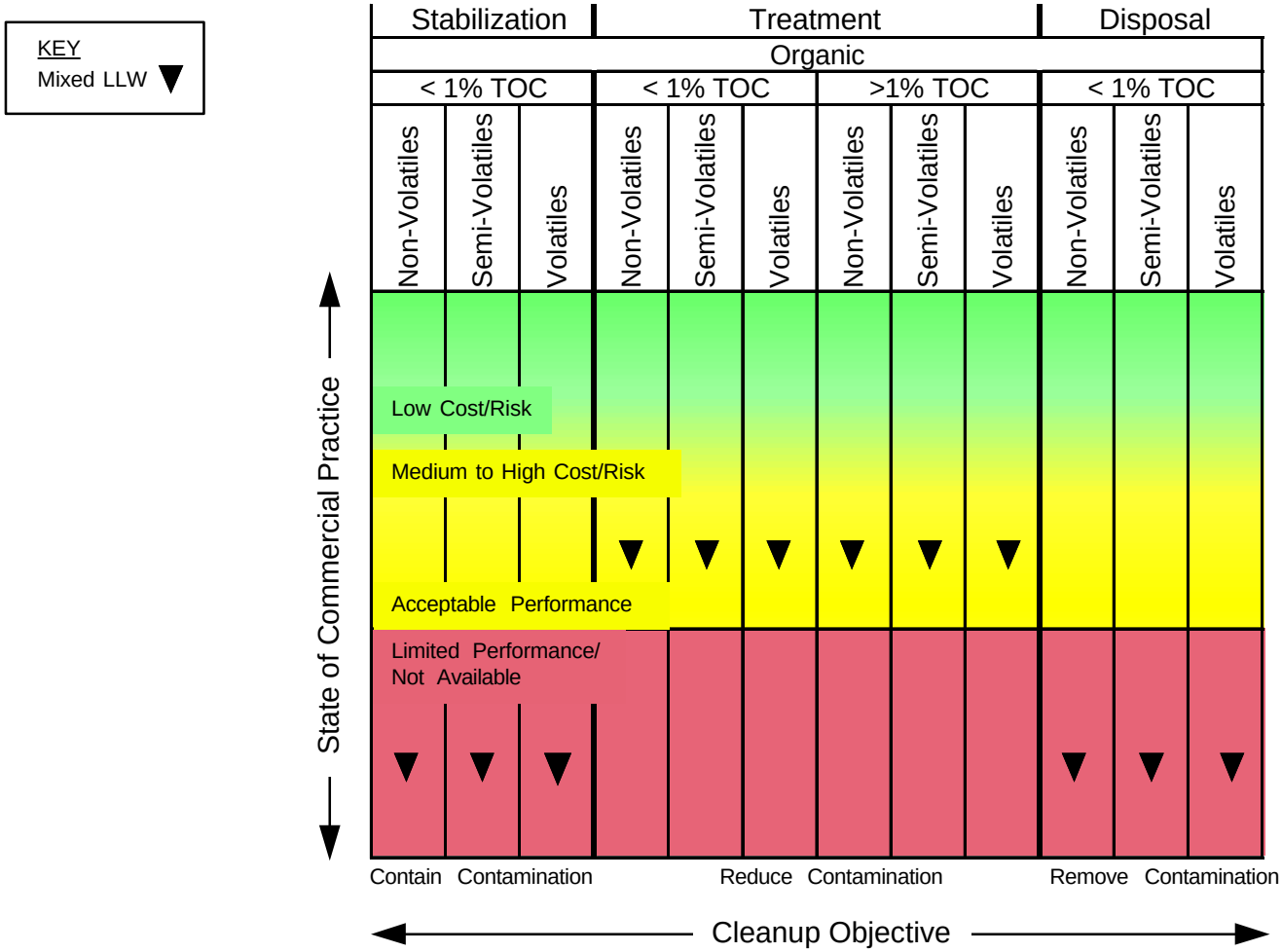
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, SIZE >1 FT., AND COMBUSTIBLES



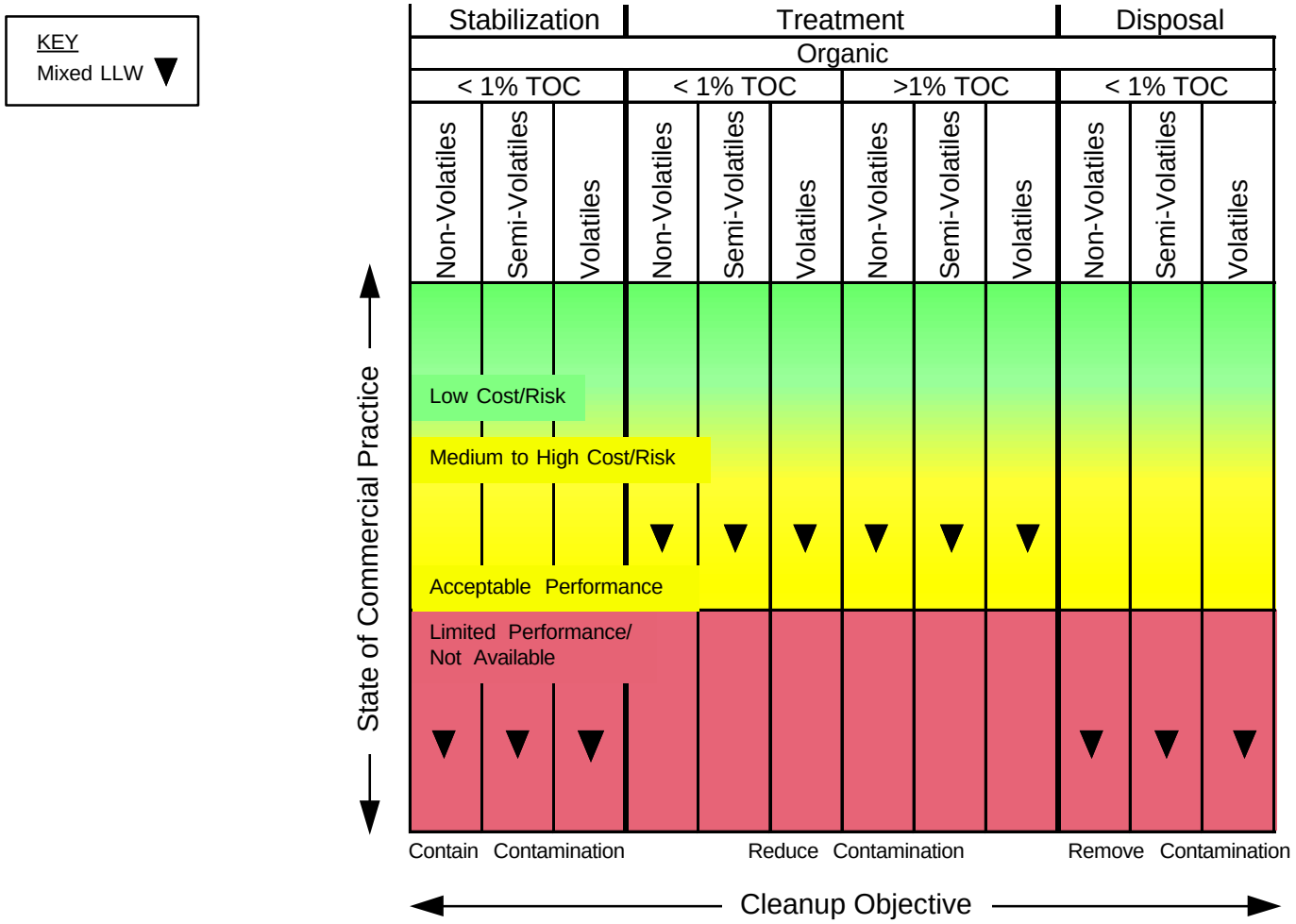
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, SIZE >1 FT., AND LEAD BRICKS



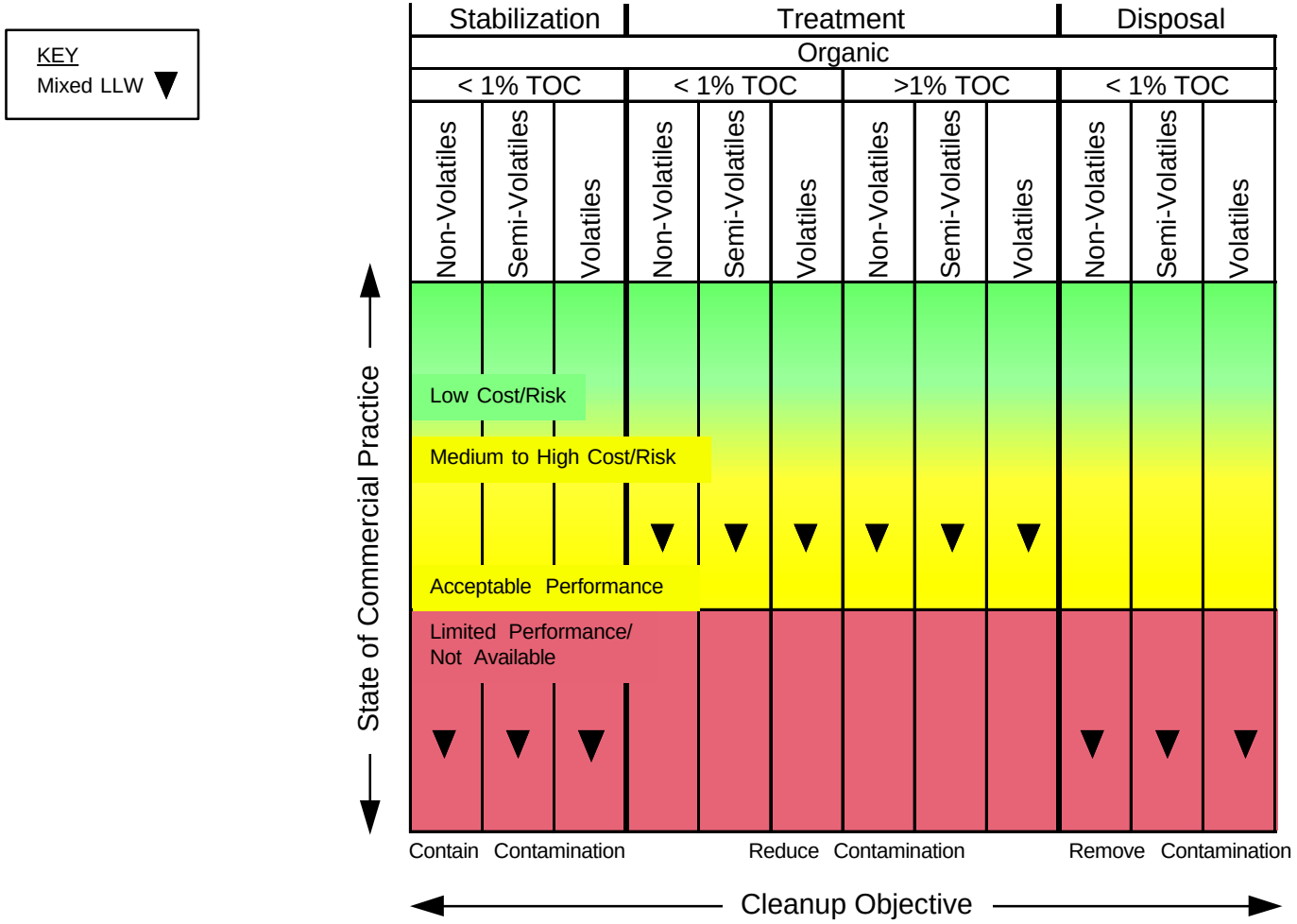
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, SIZE >1 FT., AND DISCERNABLE ENERGETICS



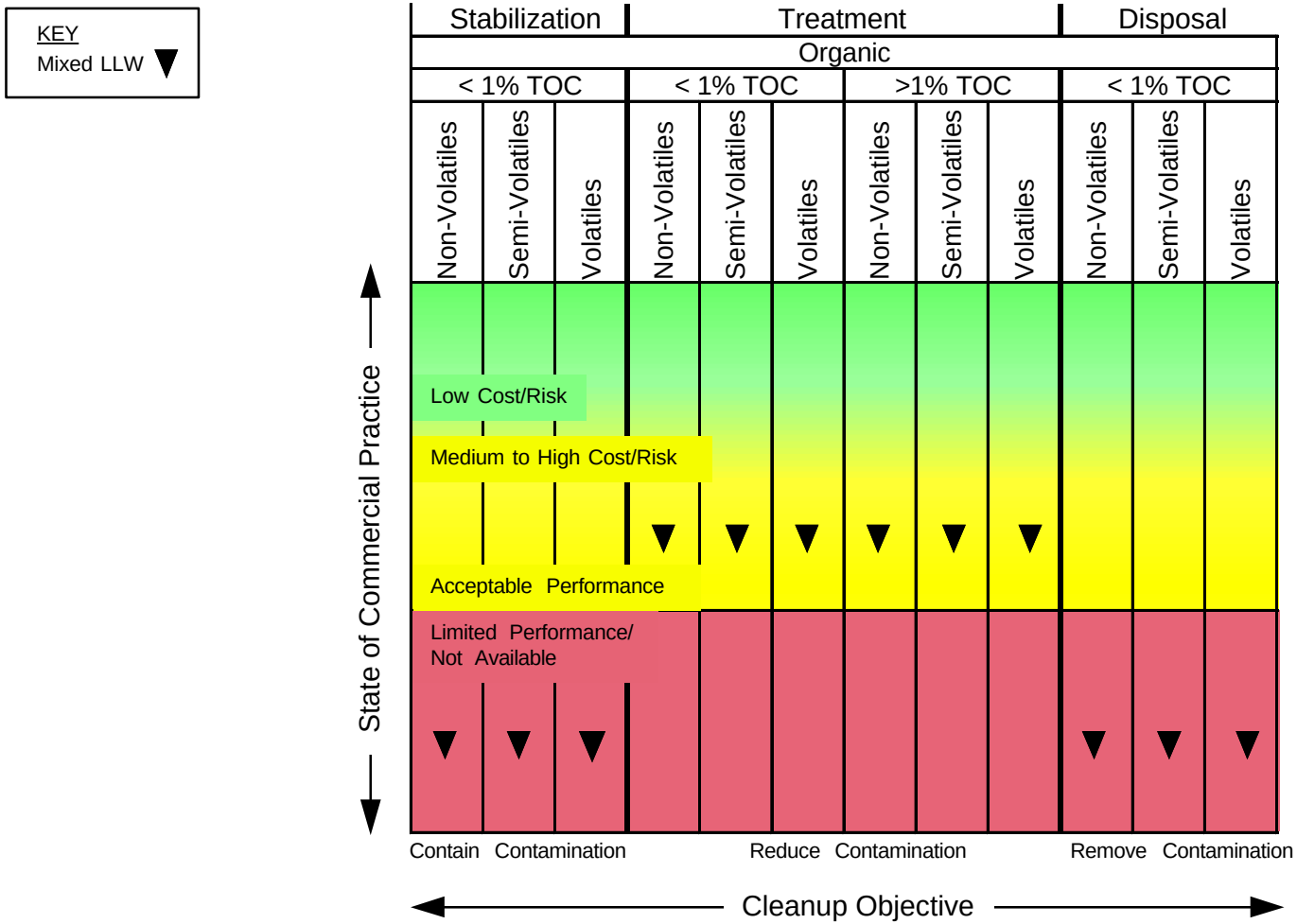
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, COMBUSTIBLES, AND LEAD BRICKS



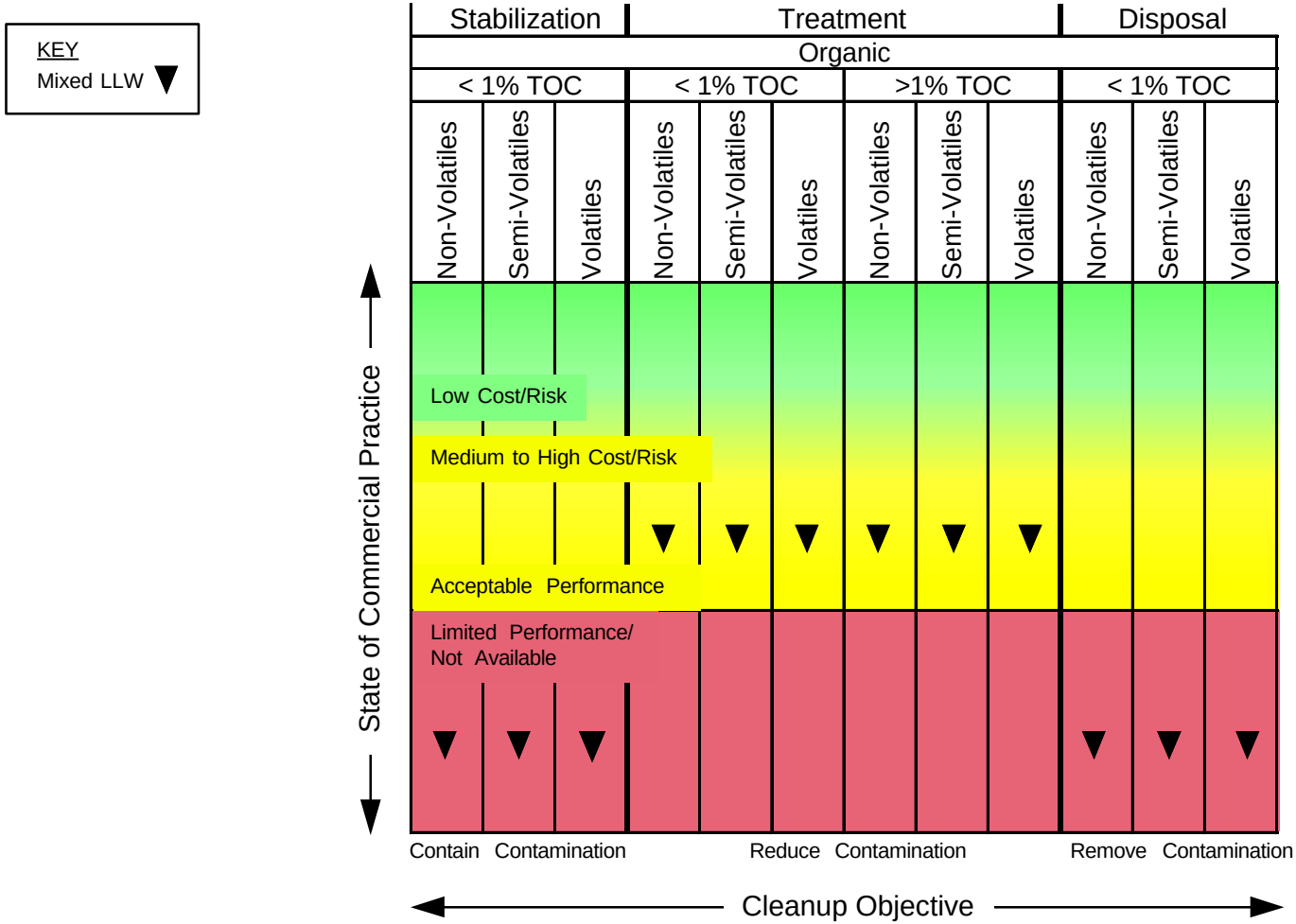
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, COMBUSTIBLES, AND DISCERNABLE ENERGETICS



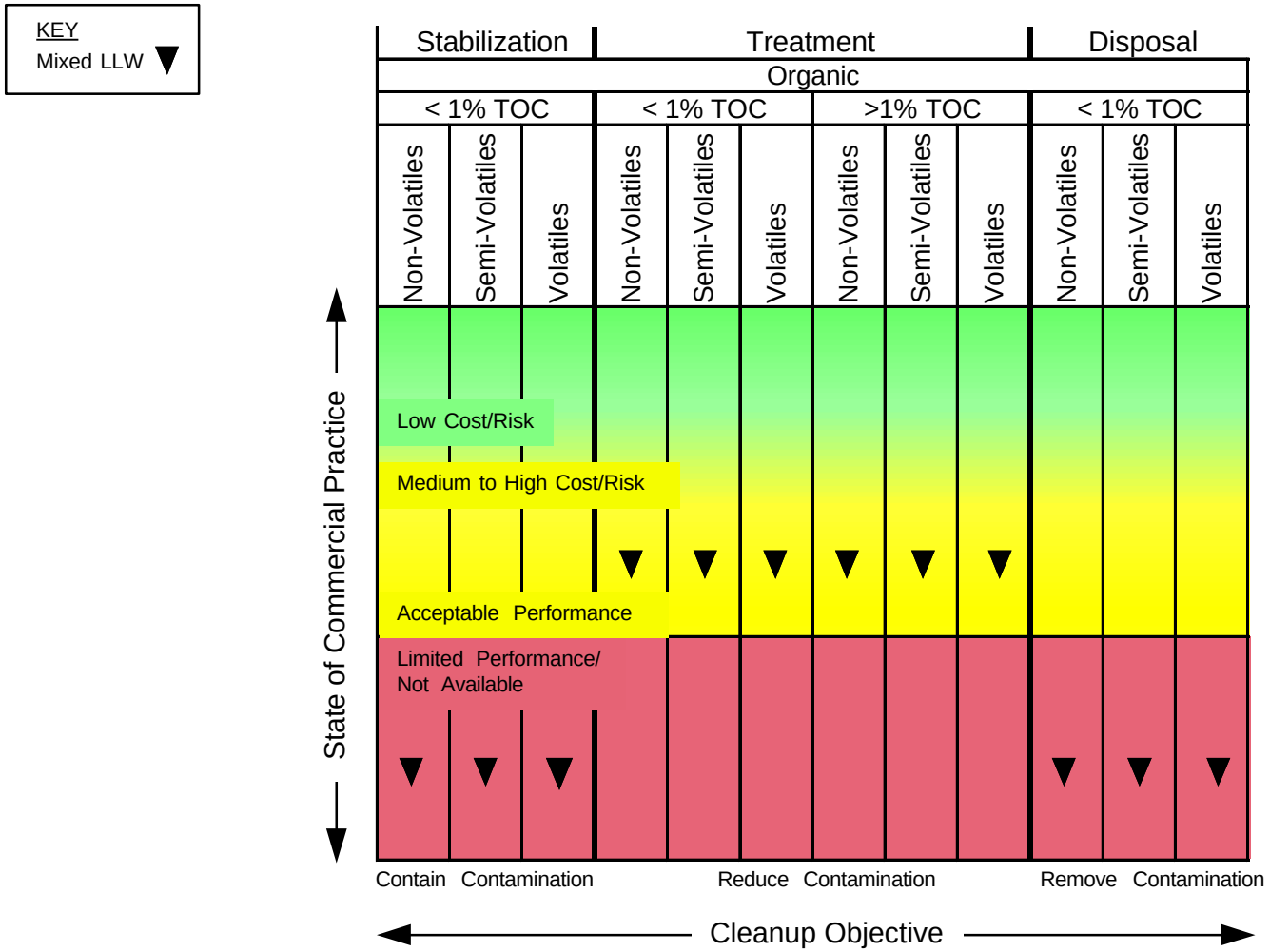
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, LEAD BRICKS, AND DISCERNABLE ENERGETICS



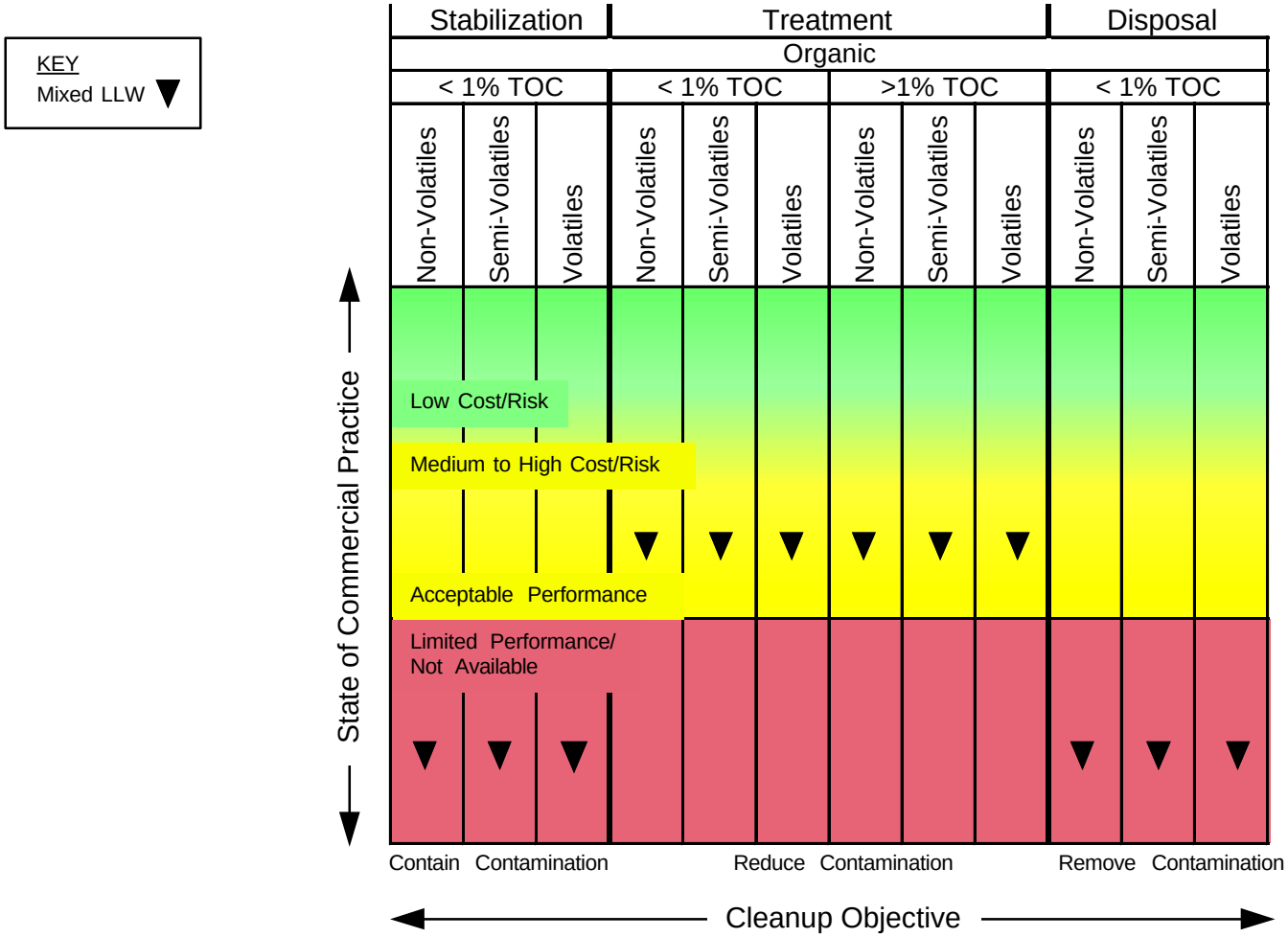
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, COMBUSTIBLES, AND LEAD BRICKS



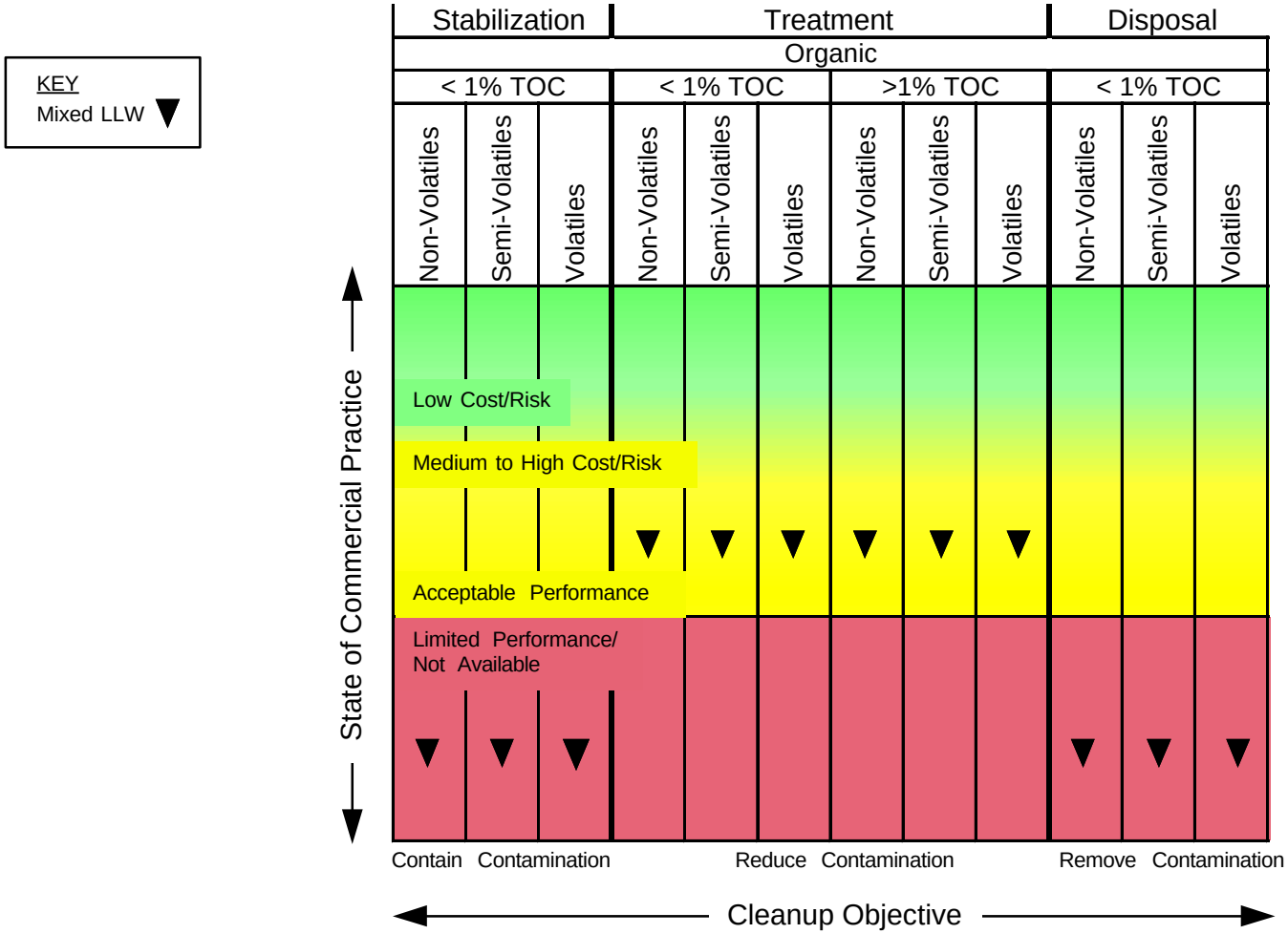
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



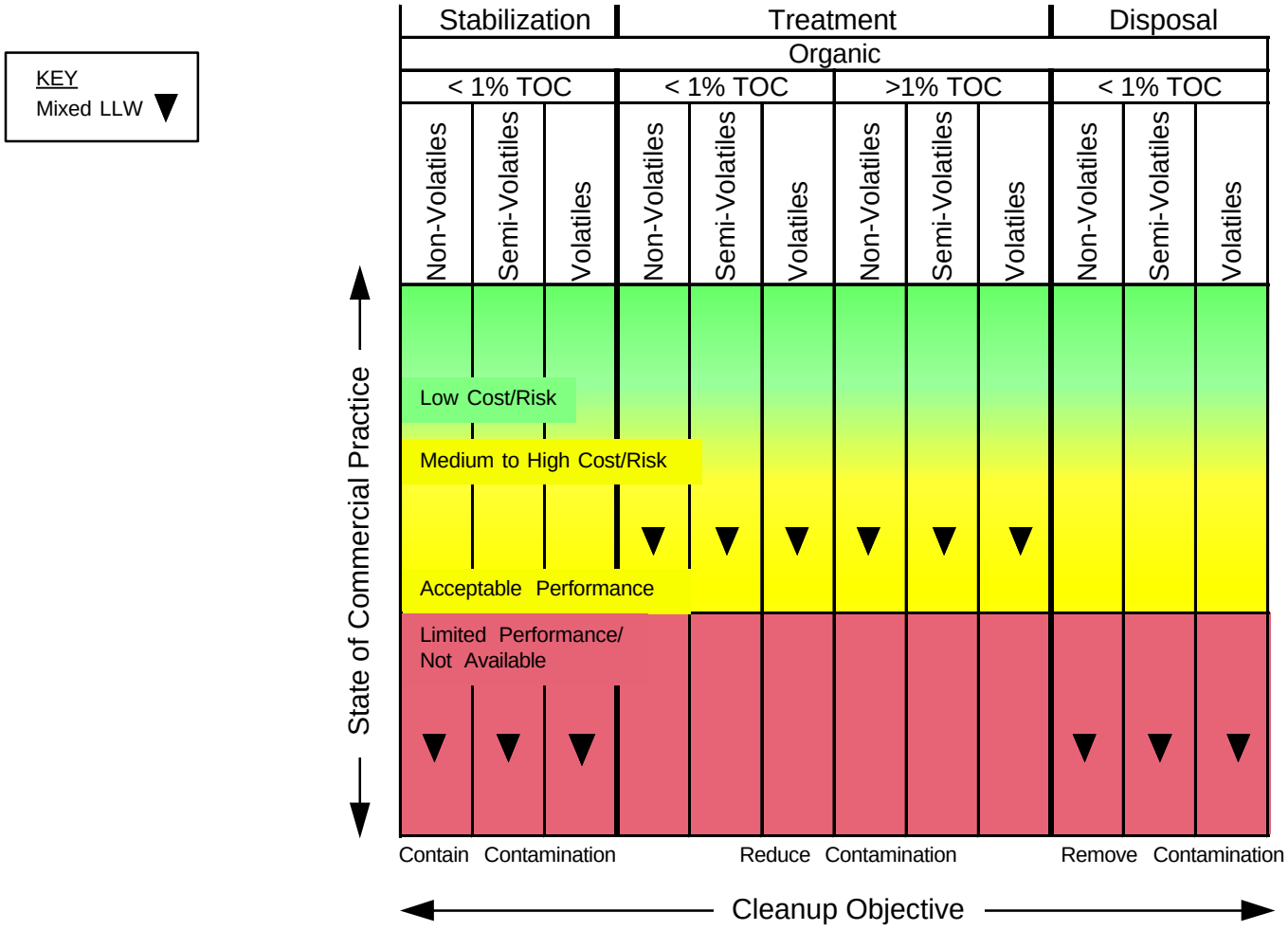
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, SIZE >1FT., LEAD BRICKS, AND DISCERNABLE ENERGETICS



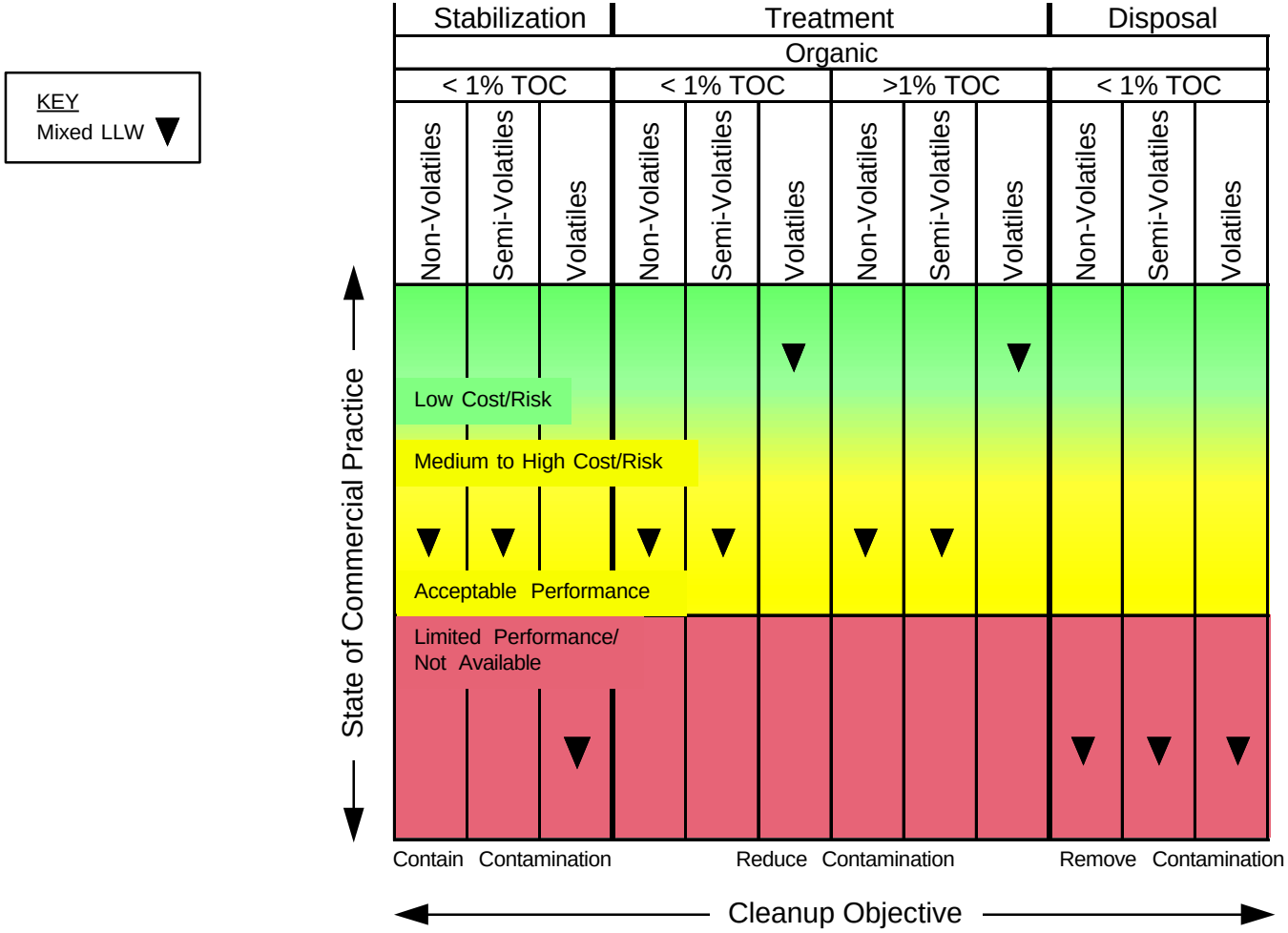
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS, COMBUSTIBLES, LEAD BRICKS, AND DISCERNABLE ENERGETICS



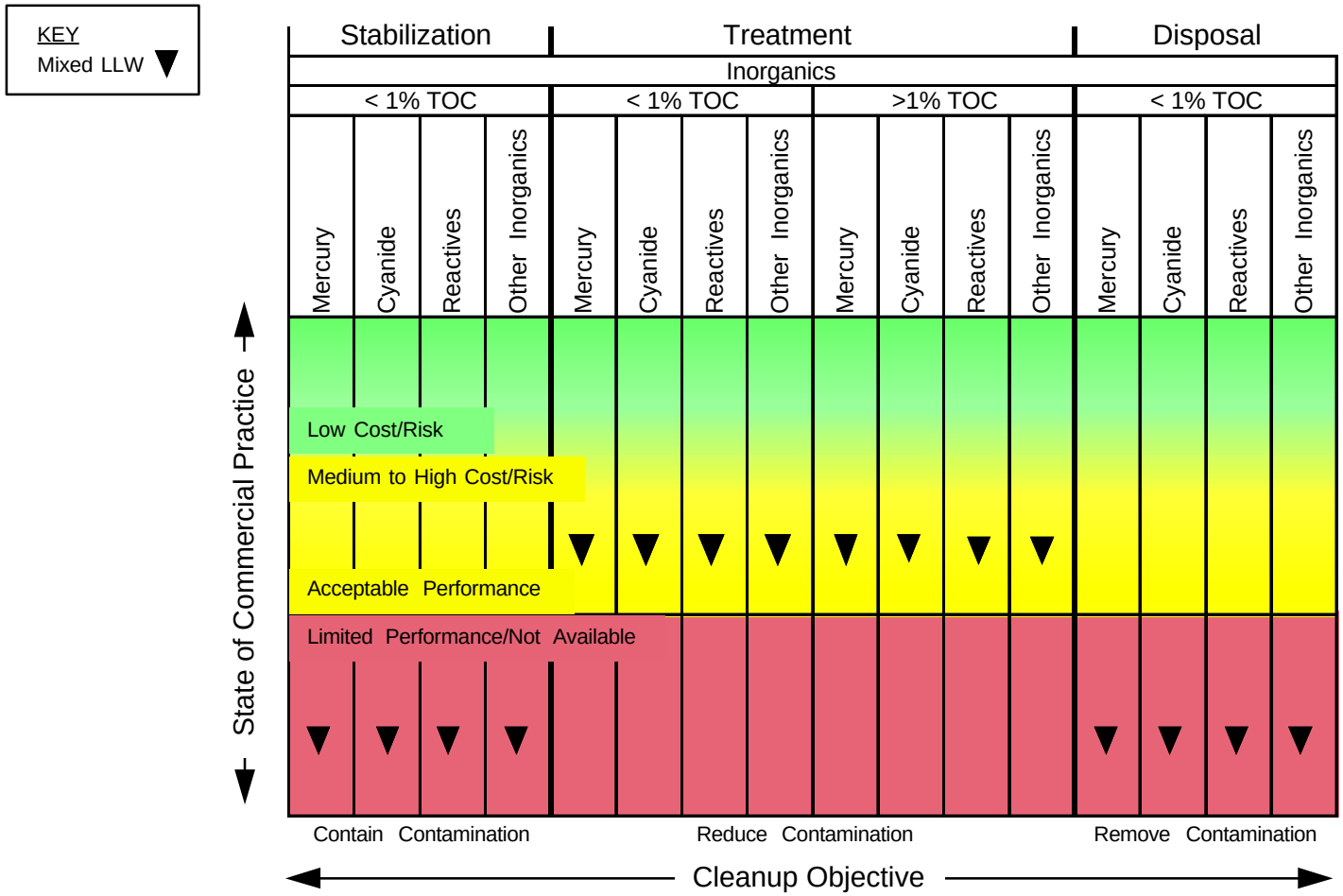
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH ORGANICS IN ALL OTHER CONDITIONS



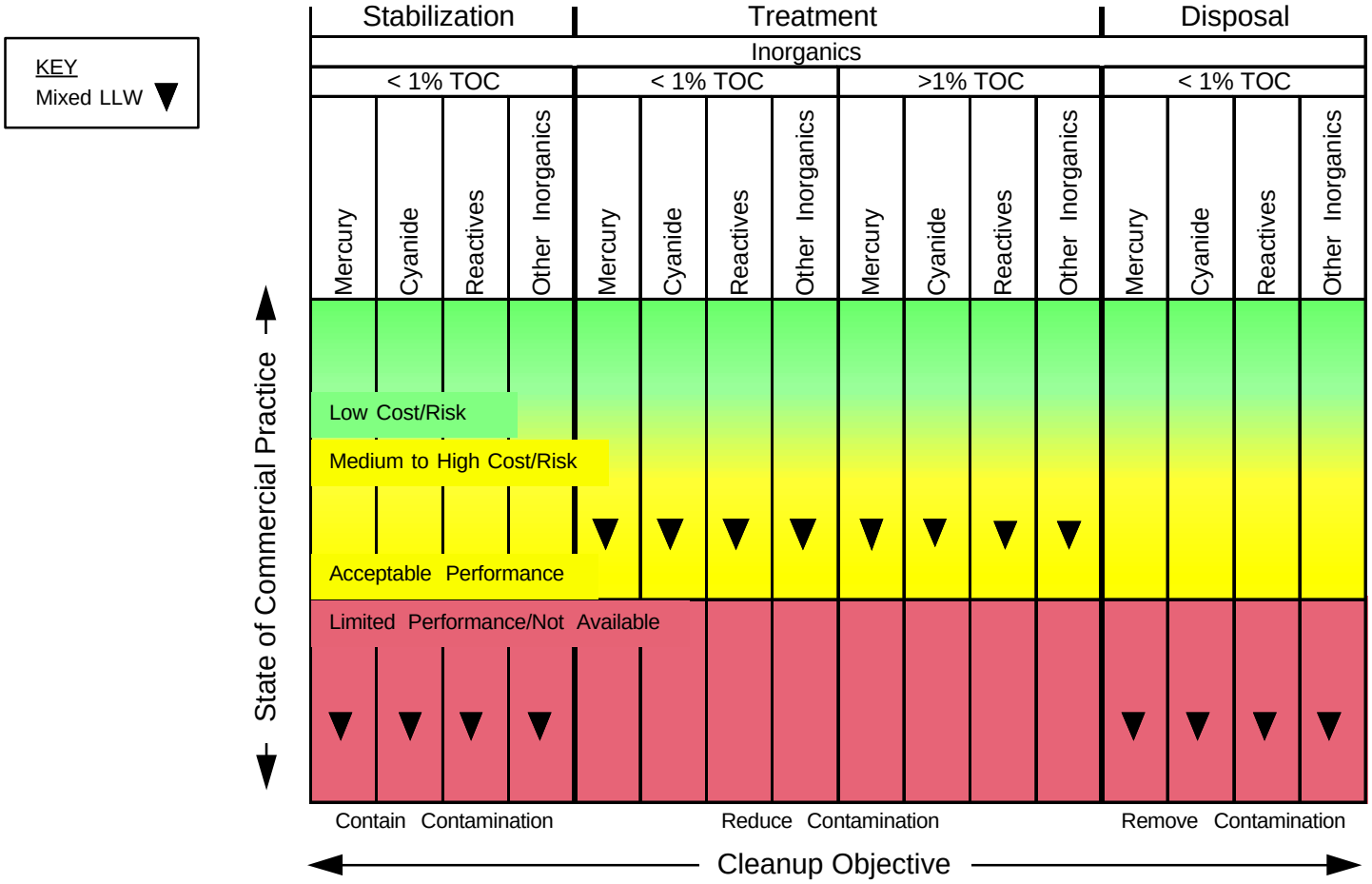
Note: Refers to Tables 54 and 58 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS AND SIZE >1 FT.



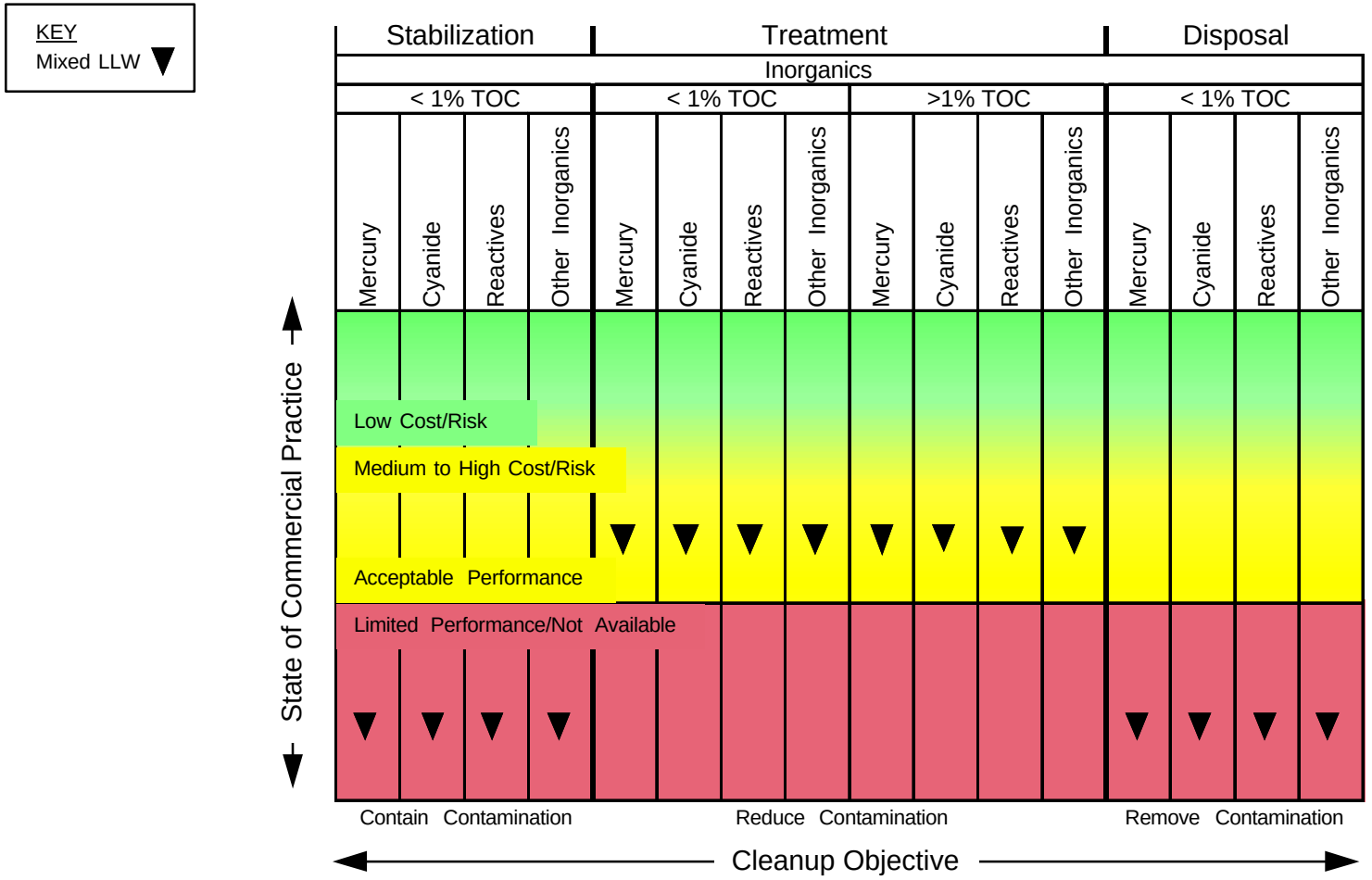
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS AND COMBUSTIBLES



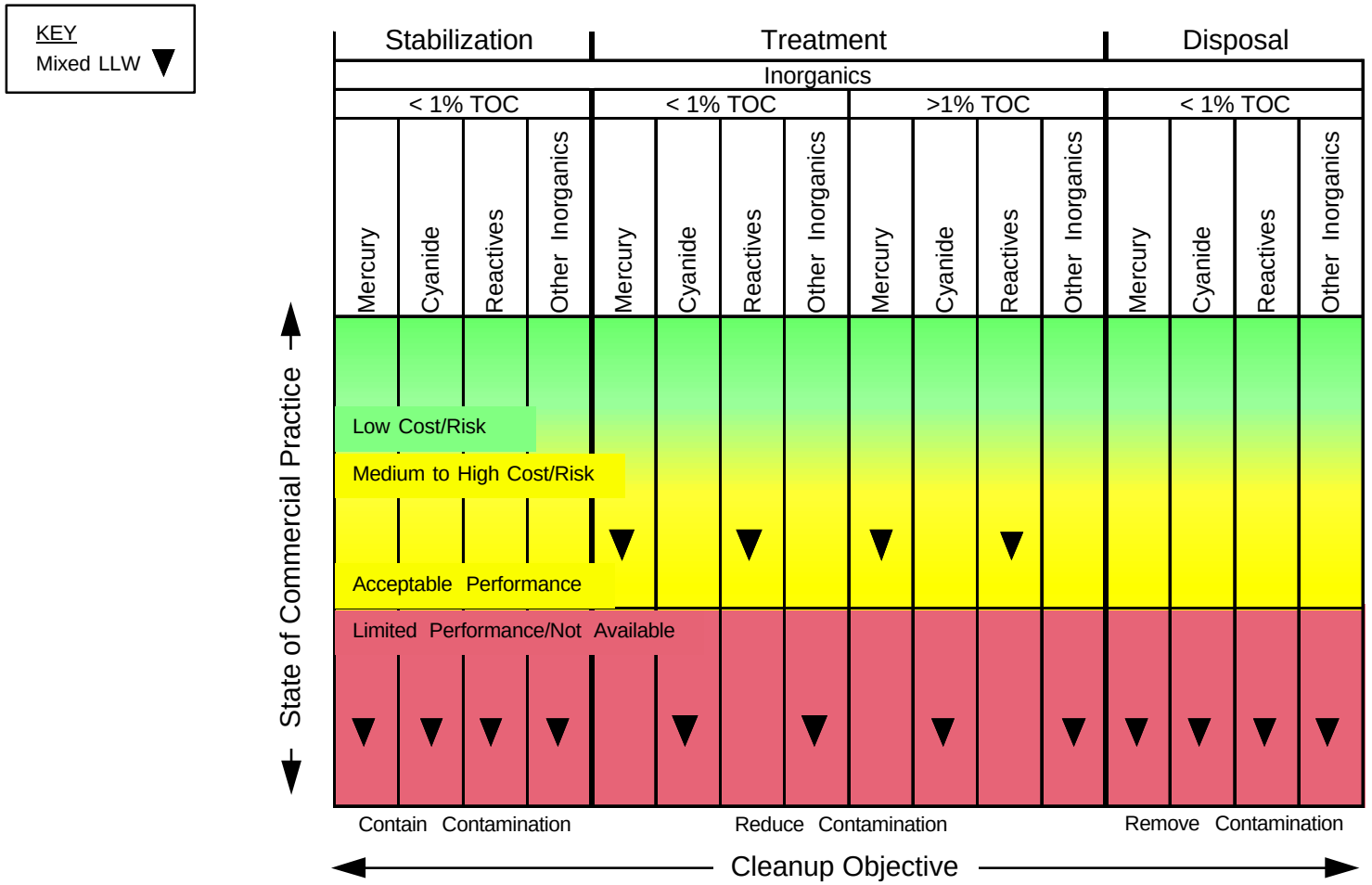
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS AND LEAD BRICKS



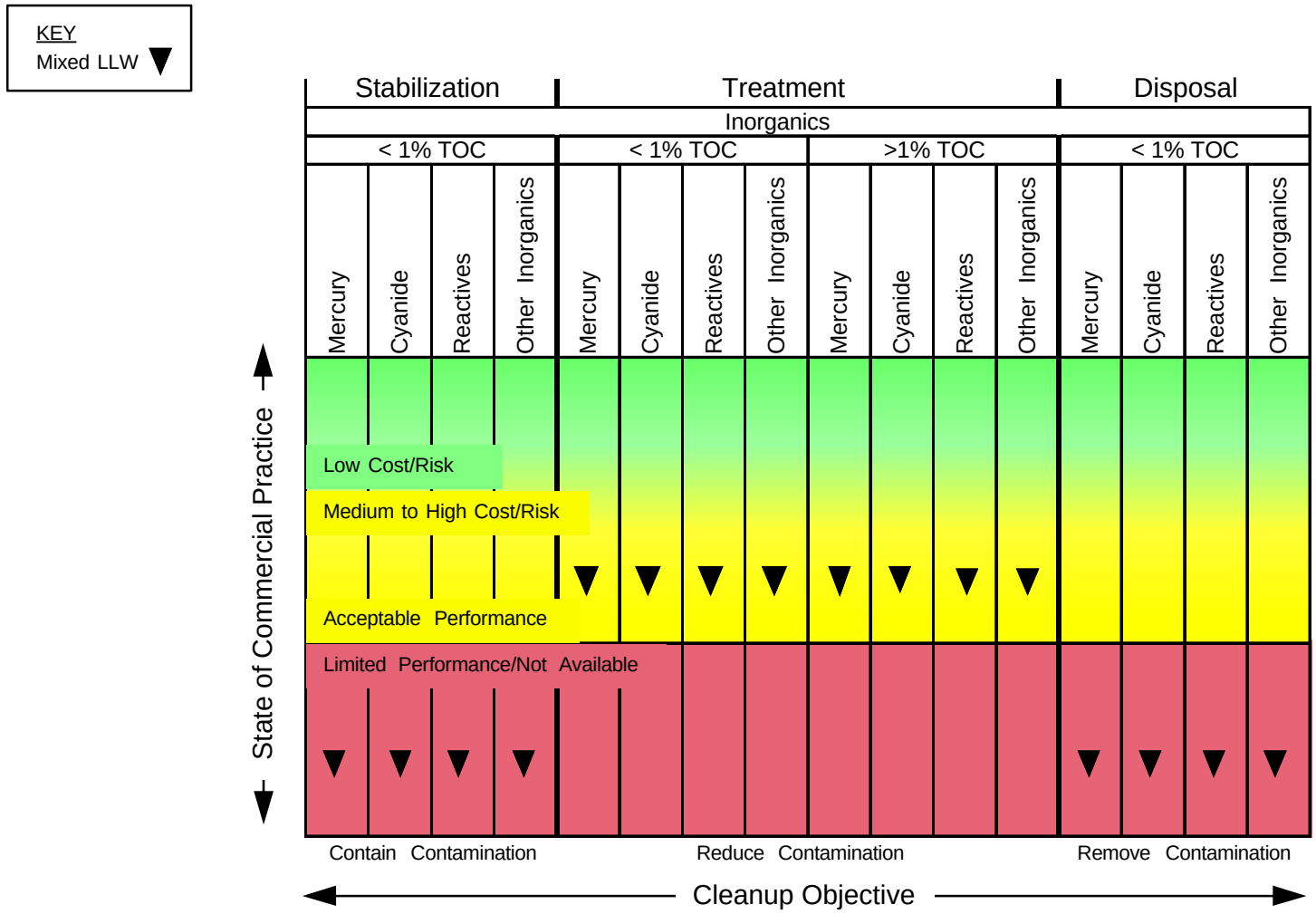
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS AND DISCERNABLE ENERGETICS



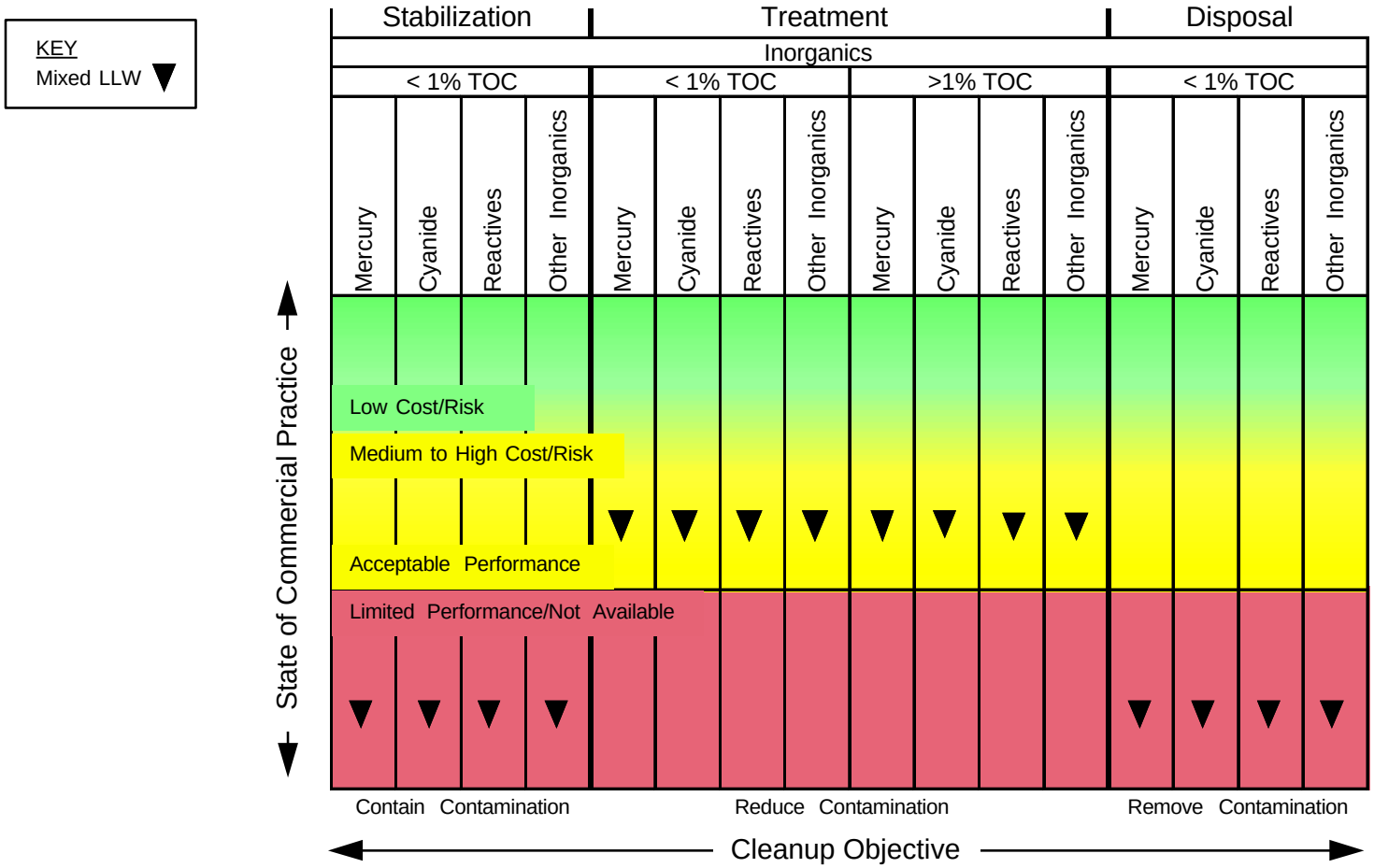
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1 FT., AND COMBUSTIBLES



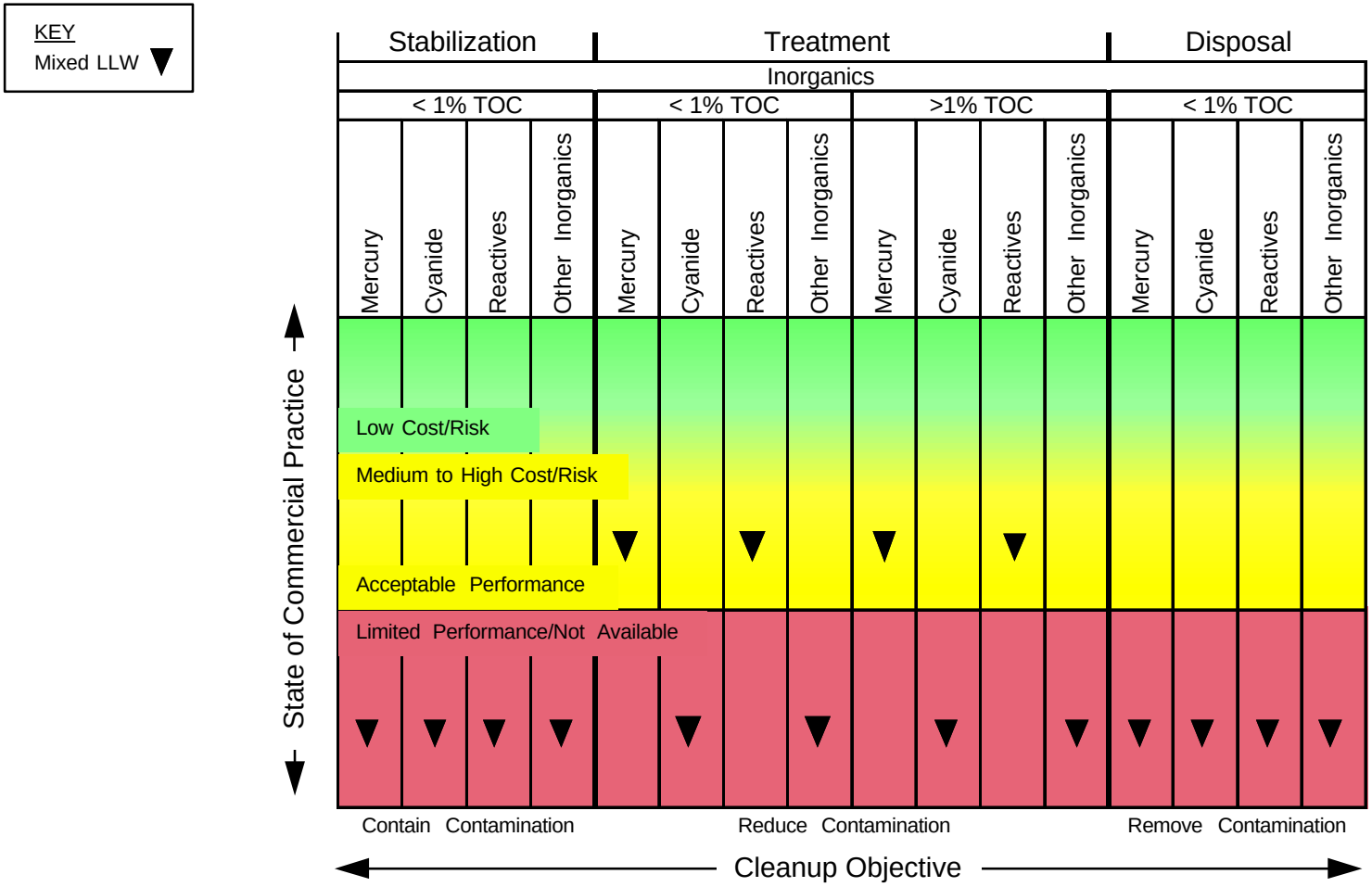
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1 FT., AND LEAD BRICKS



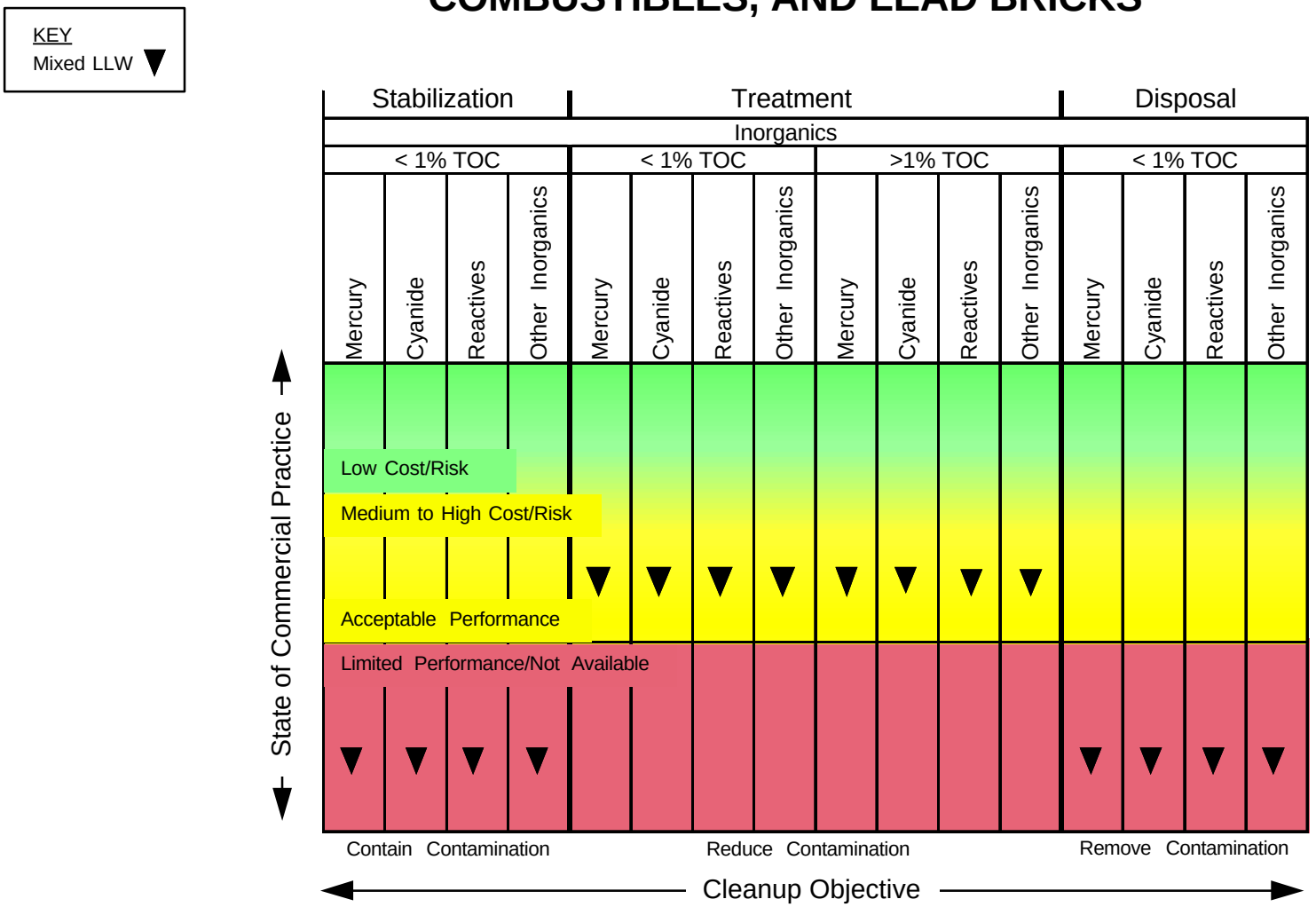
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1 FT., AND DISCERNABLE ENERGETICS



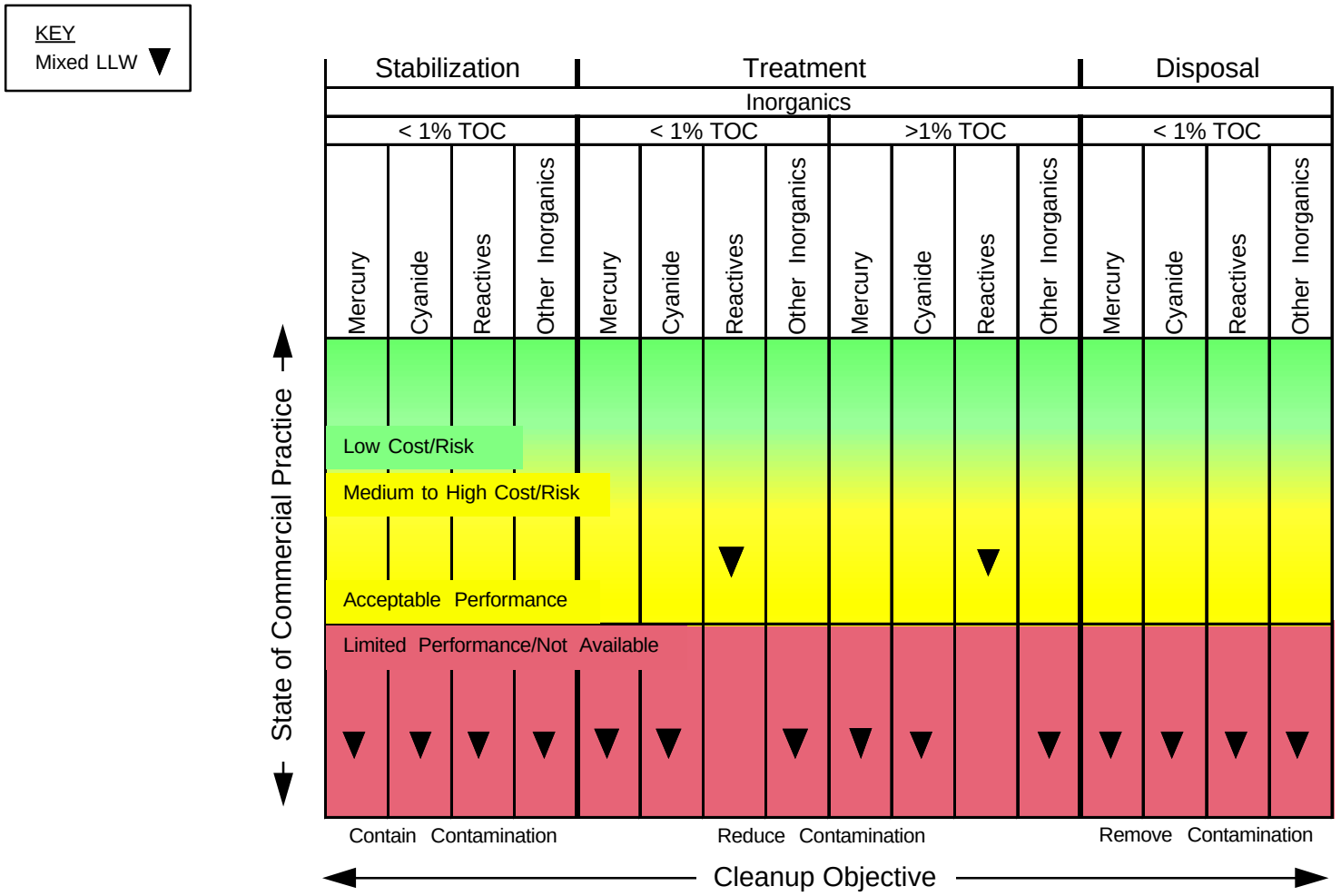
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, COMBUSTIBLES, AND LEAD BRICKS



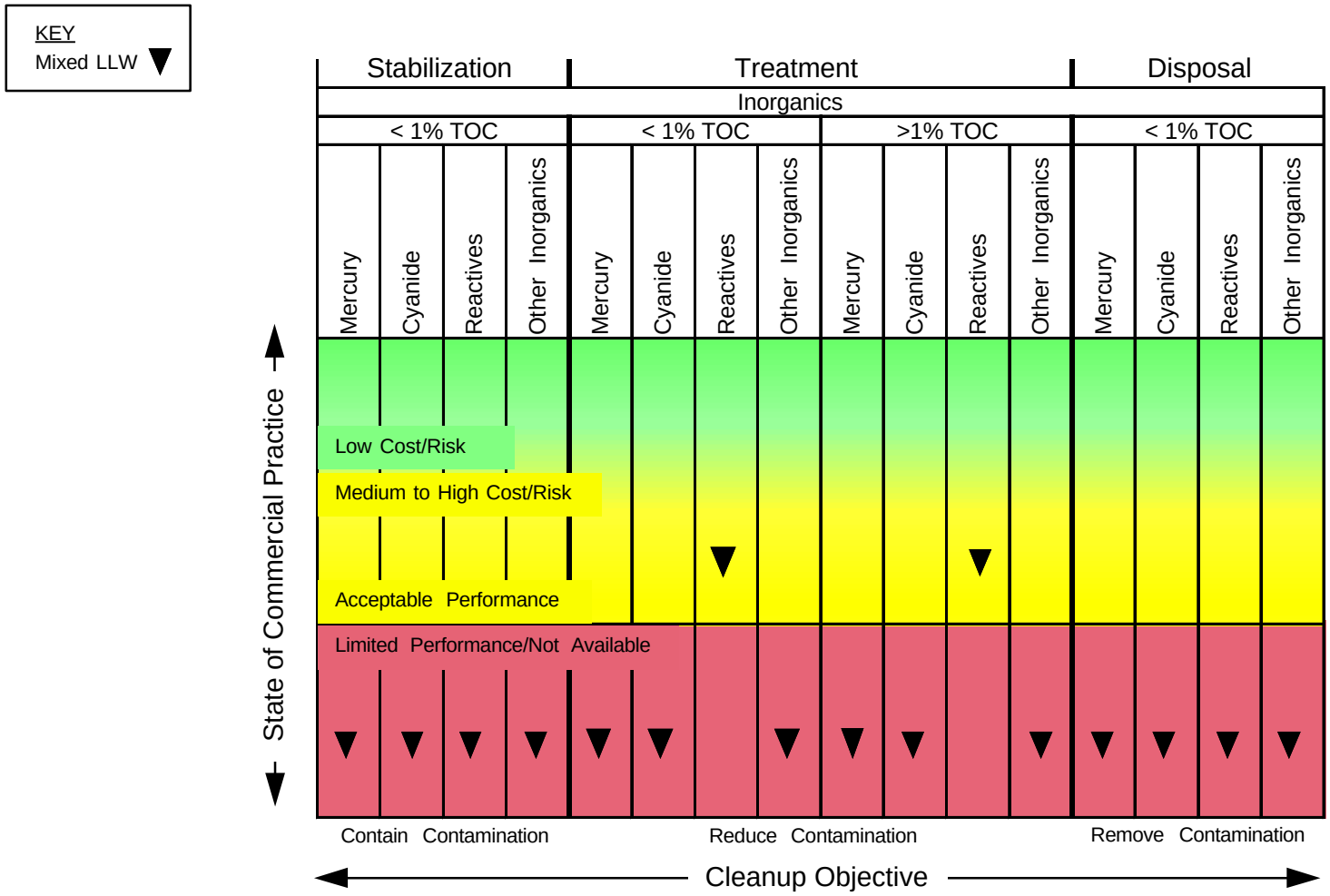
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, COMBUSTIBLES, AND DISCERNABLE ENERGETICS



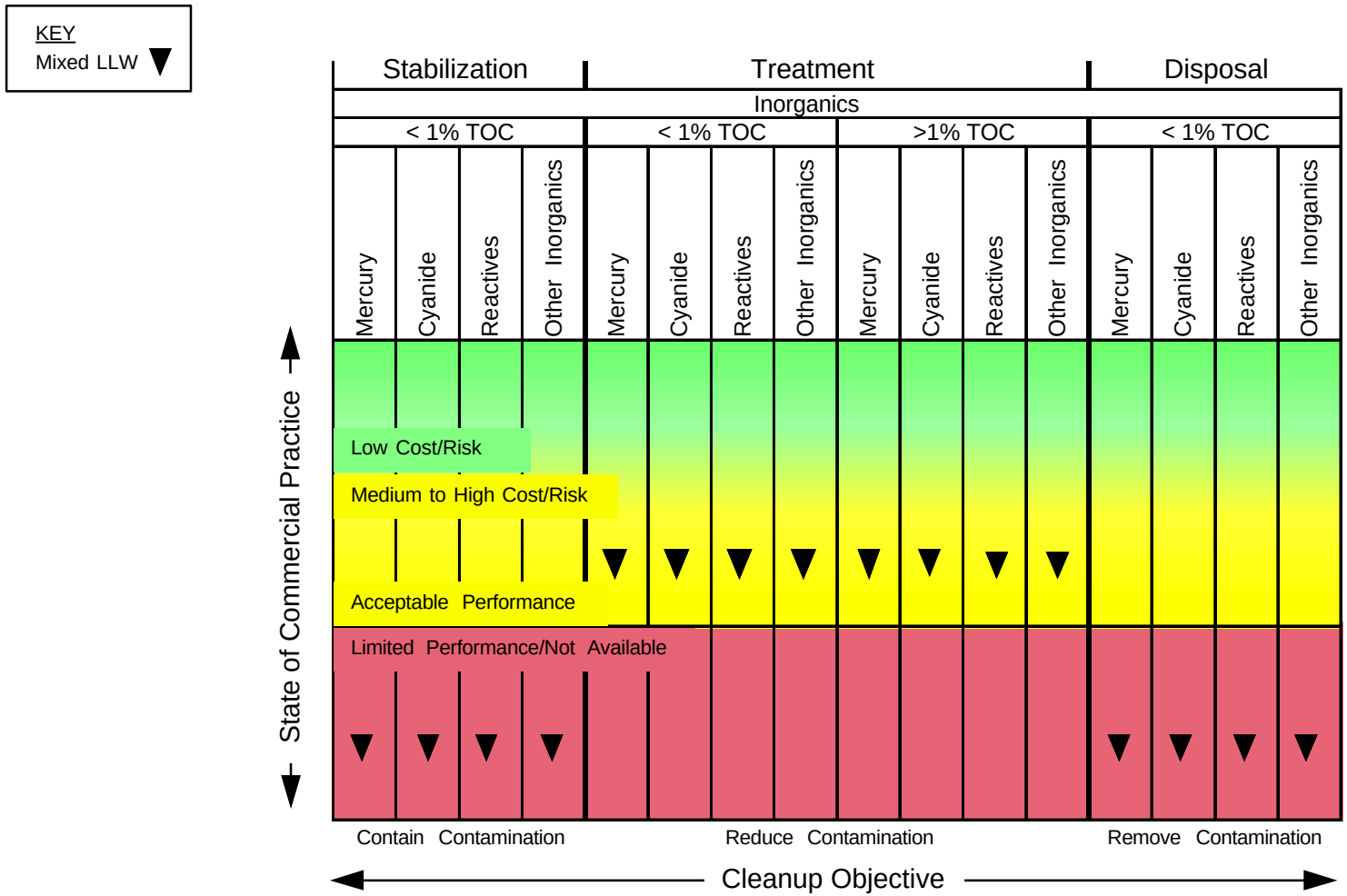
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, LEAD BRICKS, AND DISCERNABLE ENERGETICS



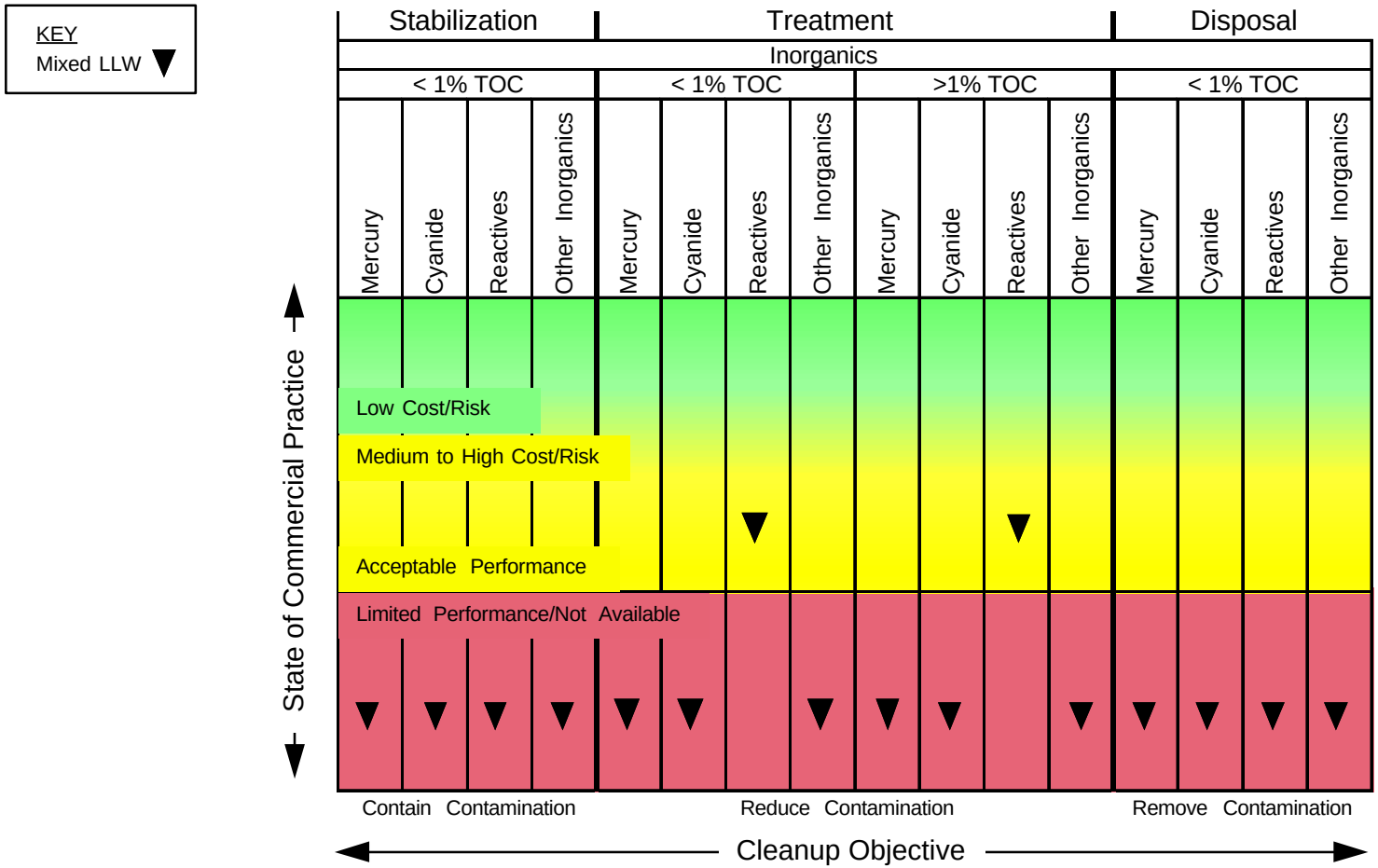
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1 FT., COMBUSTIBLES, AND LEAD BRICKS



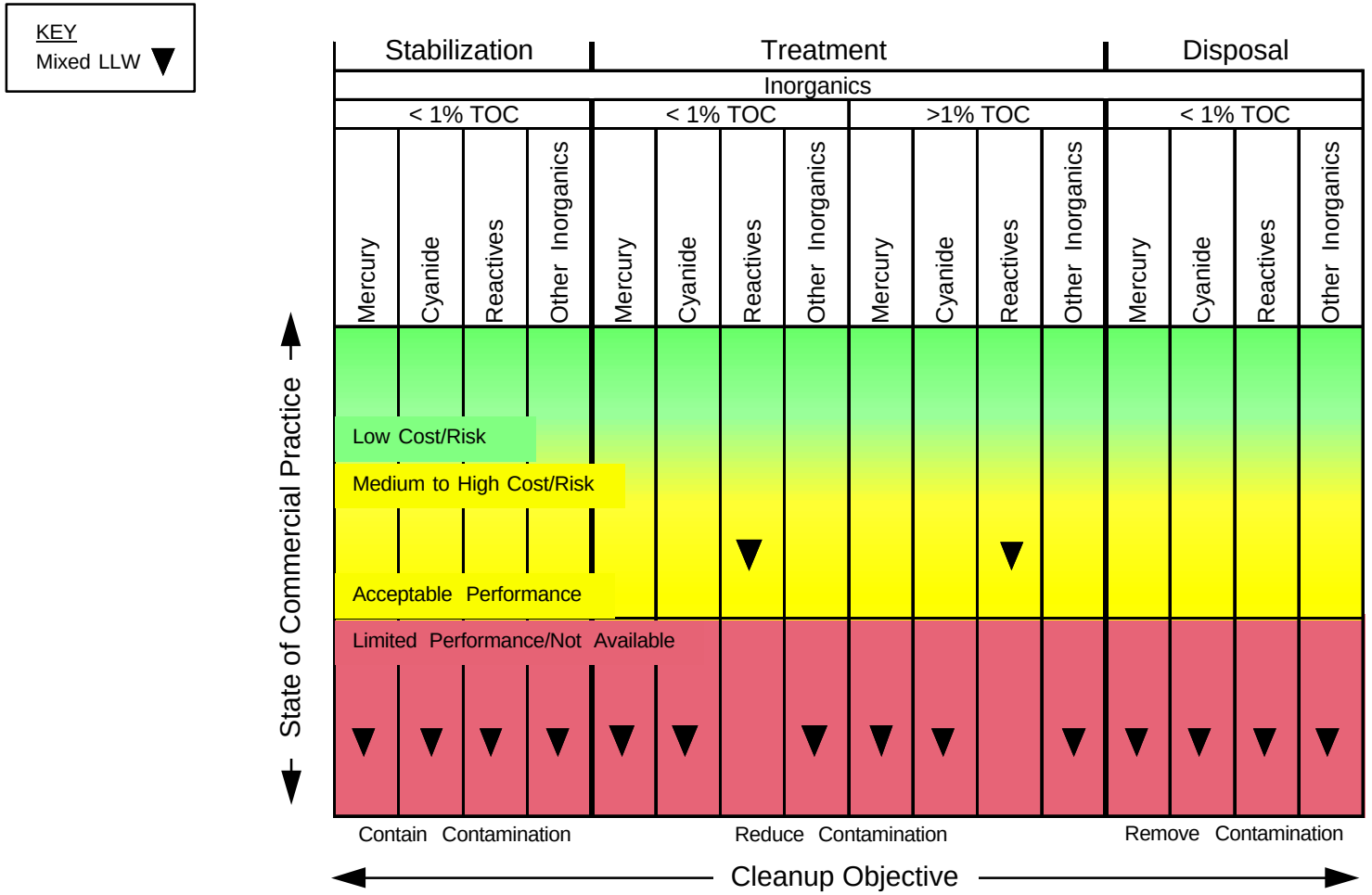
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



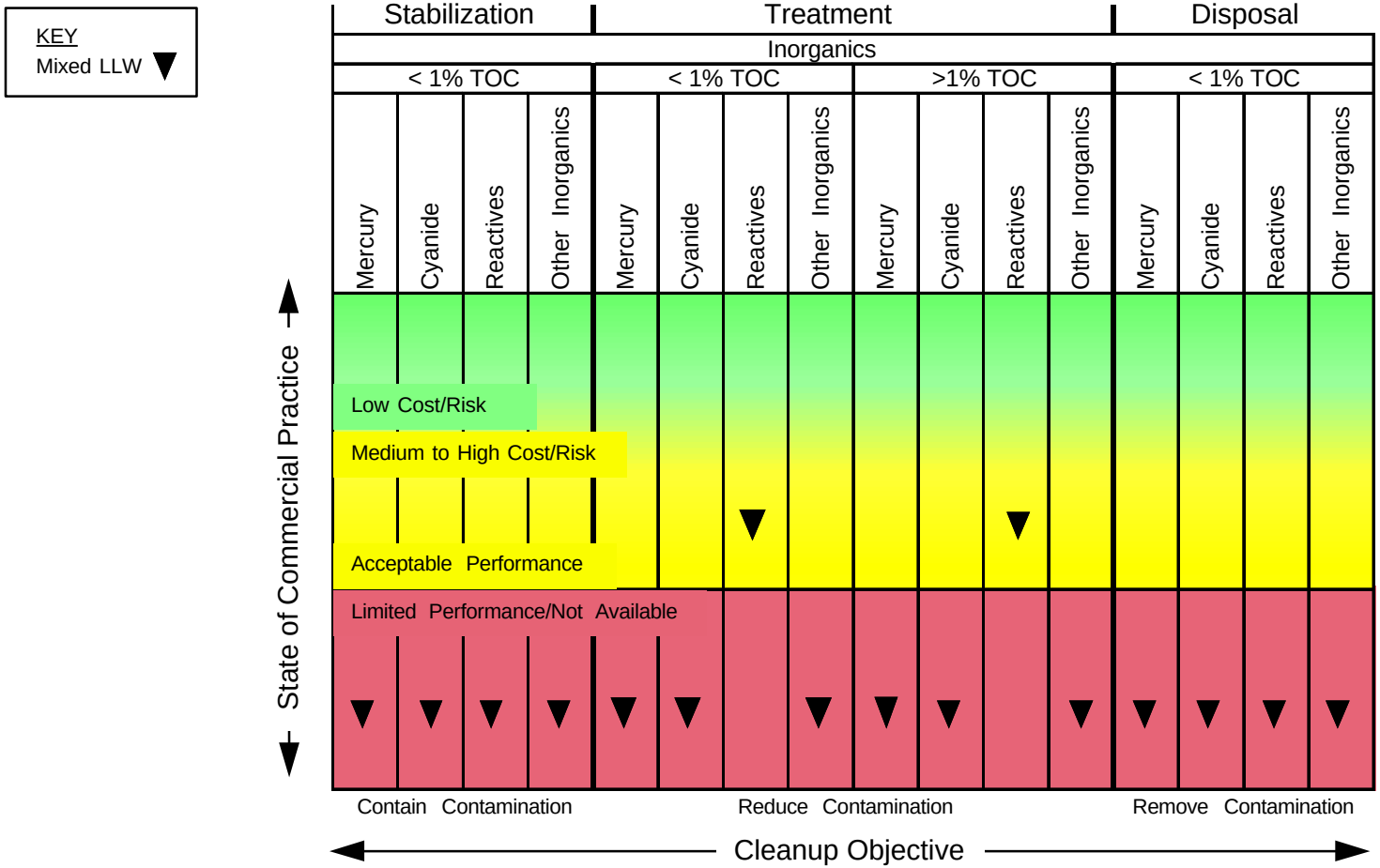
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, SIZE >1FT., LEAD BRICKS, AND DISCERNABLE ENERGETICS



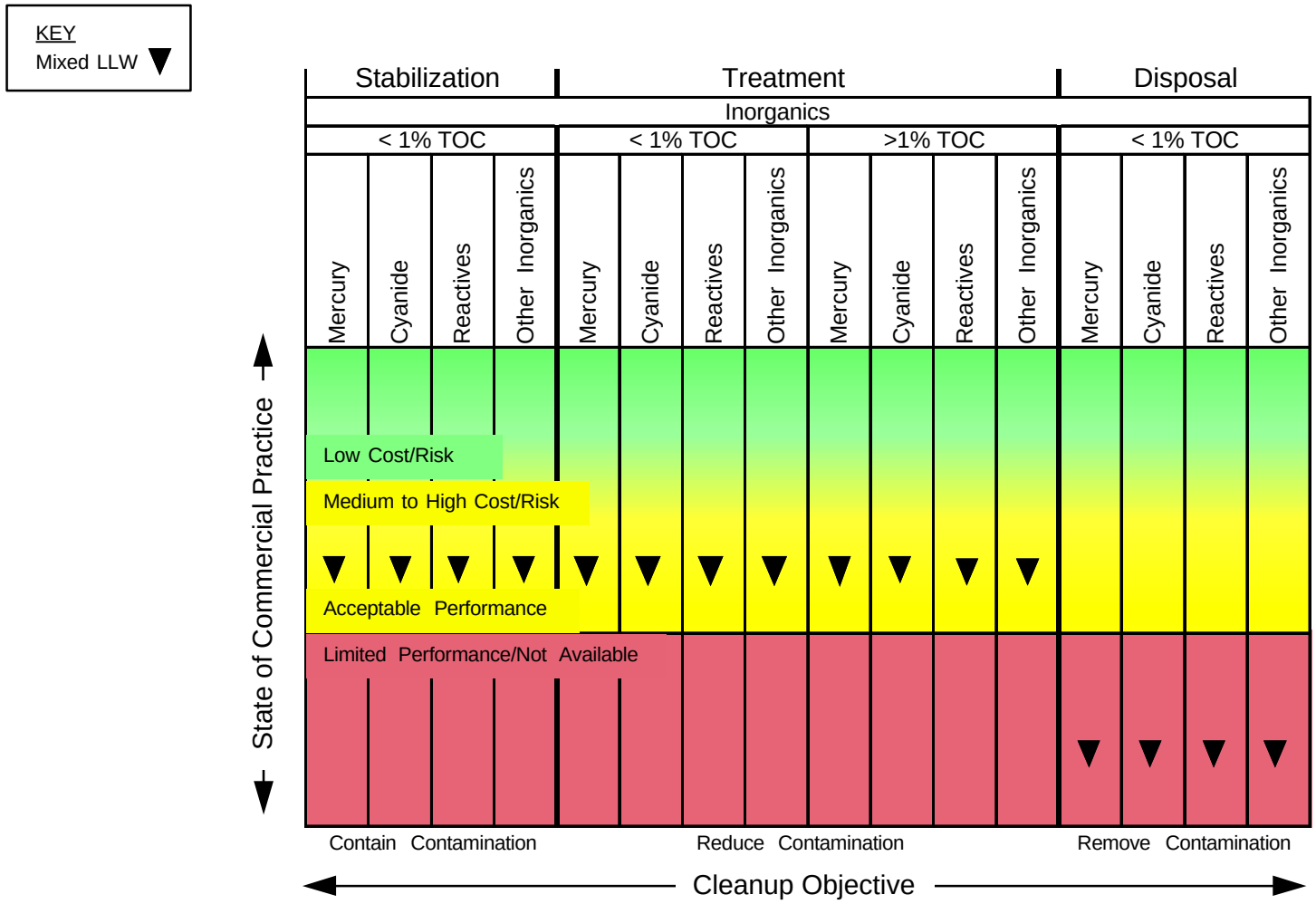
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS, COMBUSTIBLES, LEAD BRICKS, AND DISCERNABLE ENERGETICS



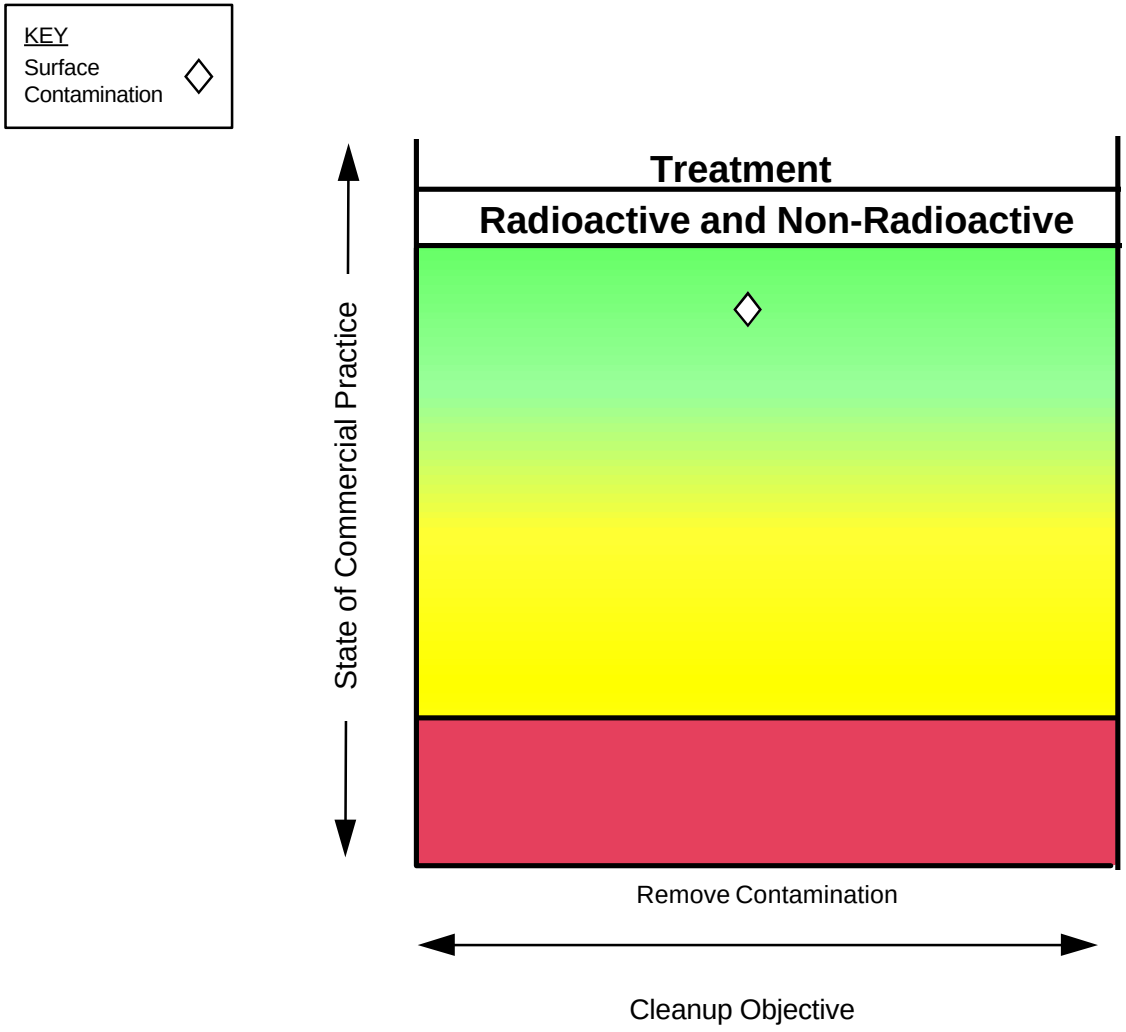
Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - MIXED LLW WITH INORGANICS IN ALL OTHER CONDITIONS



Note: Refers to Tables 54 and 59 of the Remediation/Waste Processing PAM

SOLIDS/DEBRIS - SURFACE CONTAMINATION



Note: Refers to Table 60 of the Remediation/Waste Processing PAM

STABILIZATION, TREATMENT, AND DISPOSAL OF SOLIDS/DEBRIS - MIXED LLW

- Good-performance, low-cost/risk stabilization technologies are lacking for all of the high-level conditions considered; where size is less than 1ft. and no combustibles, lead bricks, or discernable energetics are present, improvements are necessary as inorganic encapsulation is the only good-performance, low-cost/risk alternative.

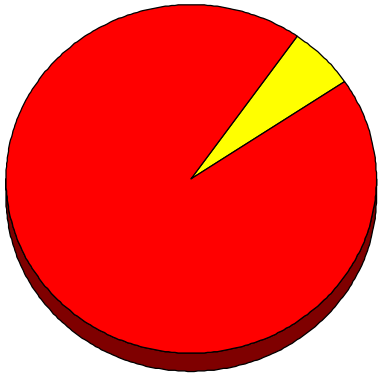
- Improvement is needed to treatment of mixed LLW with organics in all conditions with lead bricks or discernable energetics present; conversely, good-performance, low-cost/risk alternatives are available in conditions with volatiles and size greater than 1 ft. and/or combustibles present where drying/dewatering and low temperature thermal desorption are available to meet the requirement.

- Improvement is needed to treatment of mixed LLW with inorganics in almost all conditions considered; there are numerous alternatives, but few are highly rated due to performance, cost, and/or risk considerations.

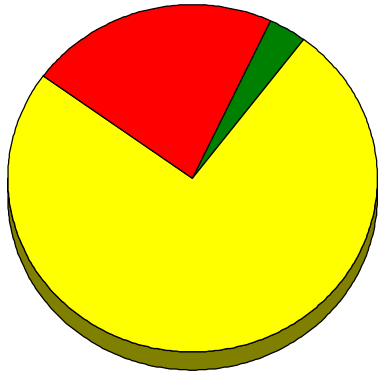
- Landfill disposal is absent for all of the conditions considered due to regulatory considerations.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR SOLIDS/DEBRIS PROBLEM SETS[1]

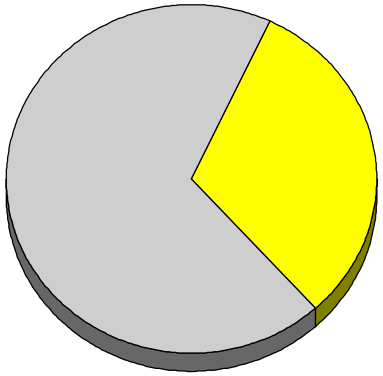
Stabilization



Treatment

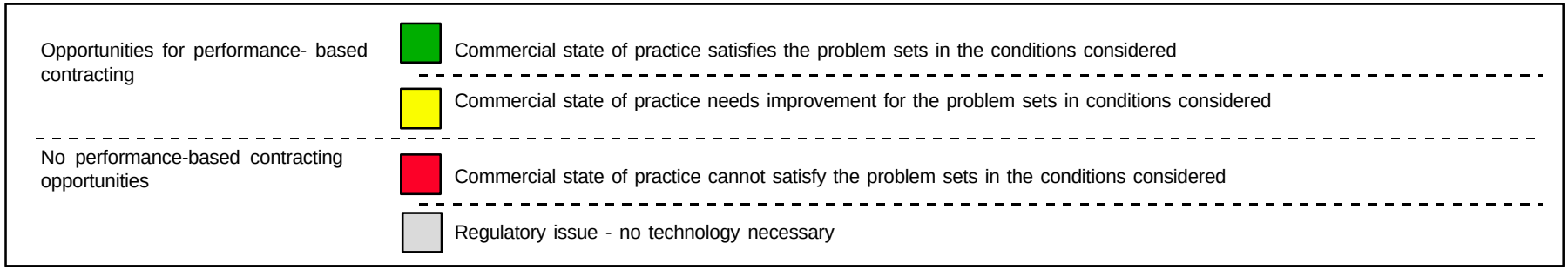


Disposal



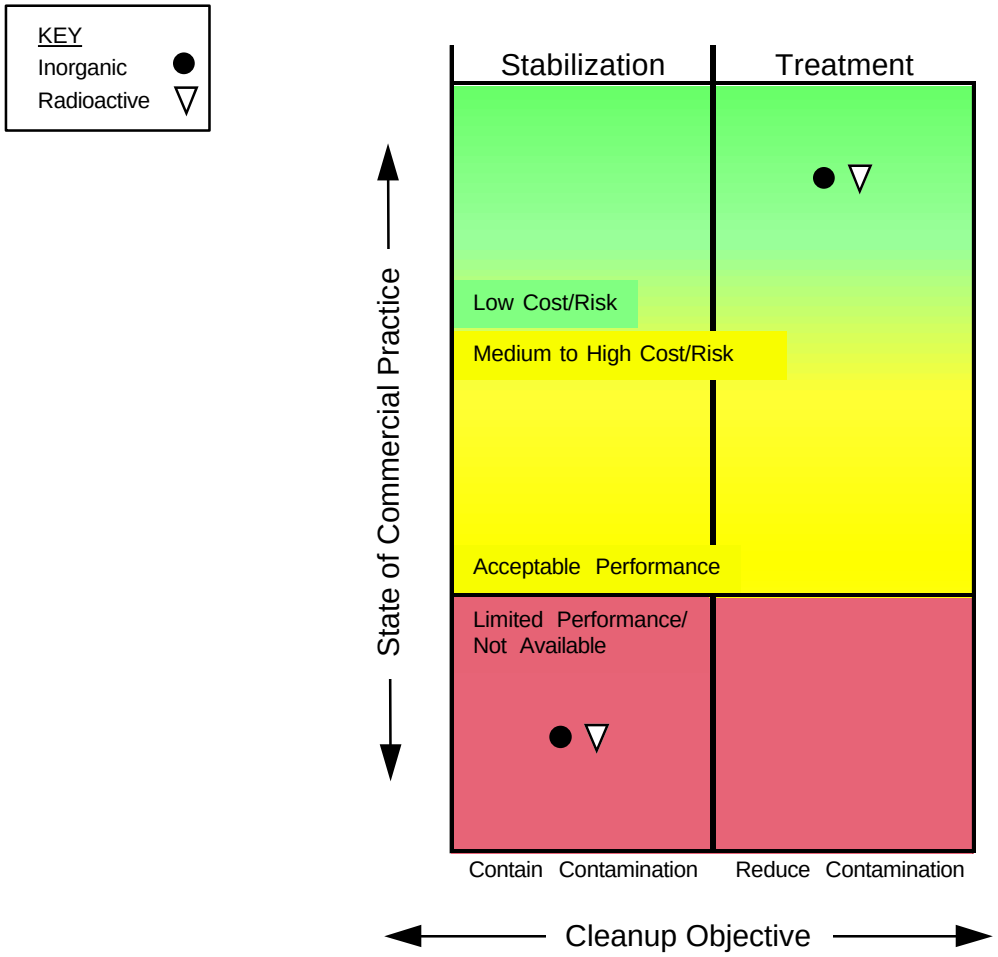
- Commercial practice does not resolve solids/debris for the majority of conditions using stabilization or disposal techniques; conversely, there are many available practices for treatment, though improvement is necessary.

- Treatment offers numerous performance-based contracting opportunities with stabilization and disposal presenting far fewer opportunities.



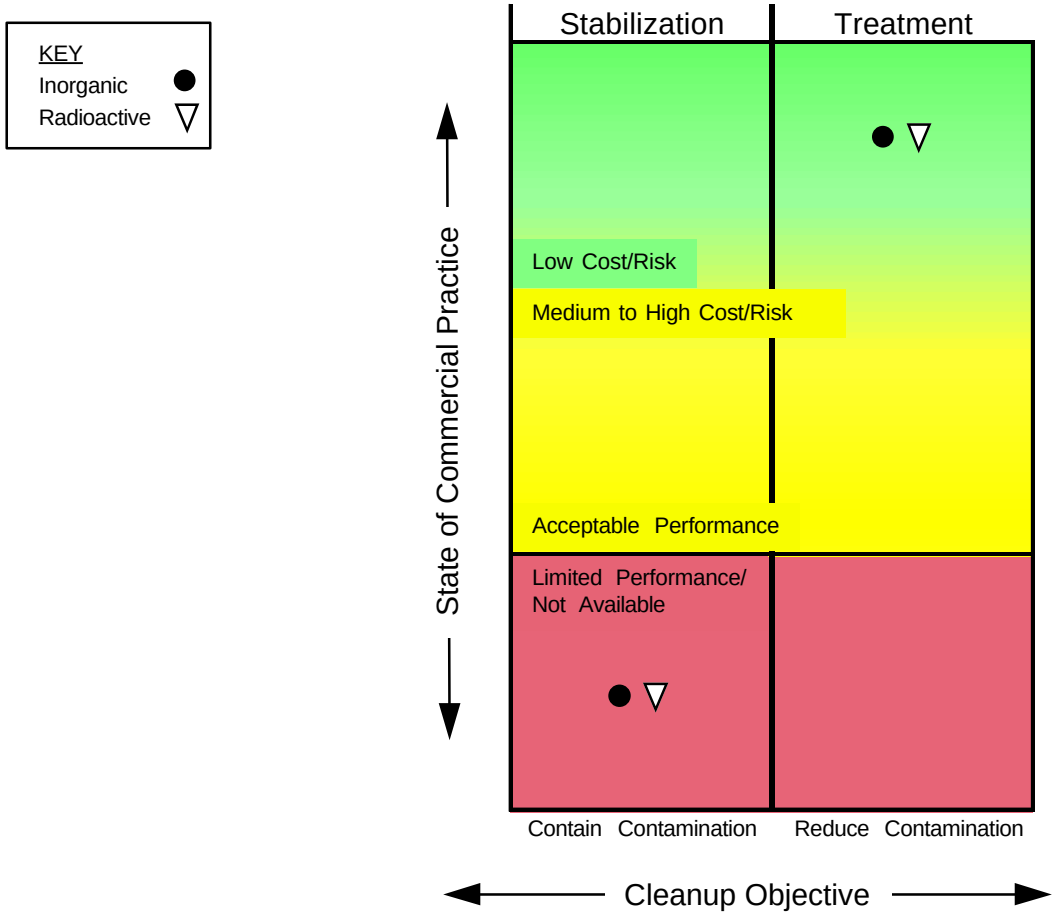
[1] Pie charts represent percentage of conditions in the PAM in which solids/debris problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

ASBESTOS WITH SIZE >1 FT.



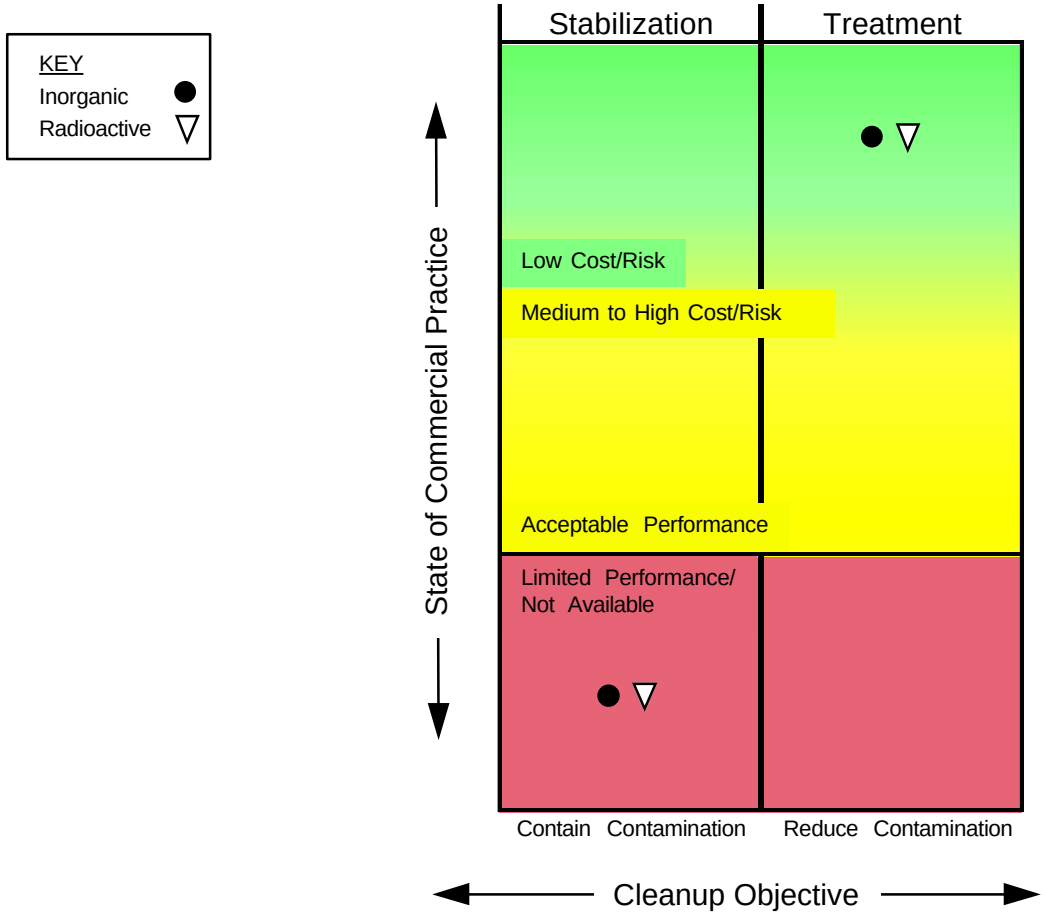
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH COMBUSTIBLES



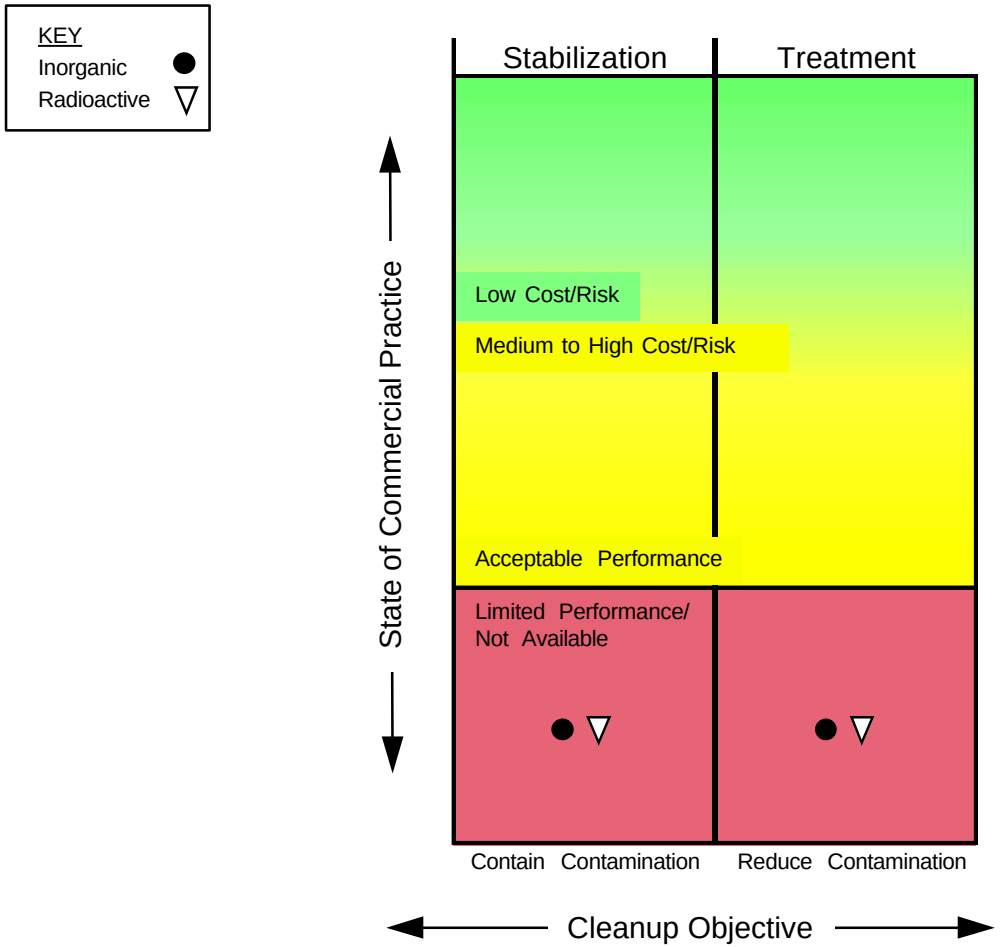
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH LEAD BRICKS



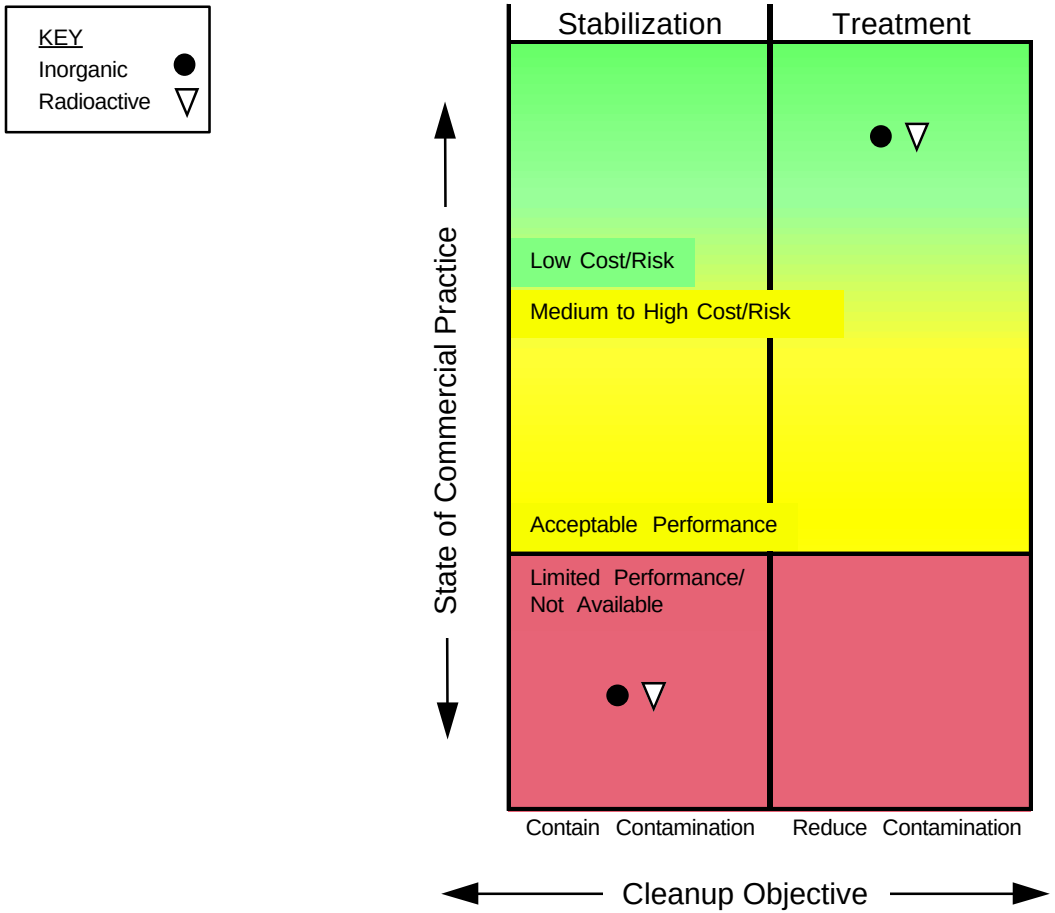
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH DISCERNABLE ENERGETICS



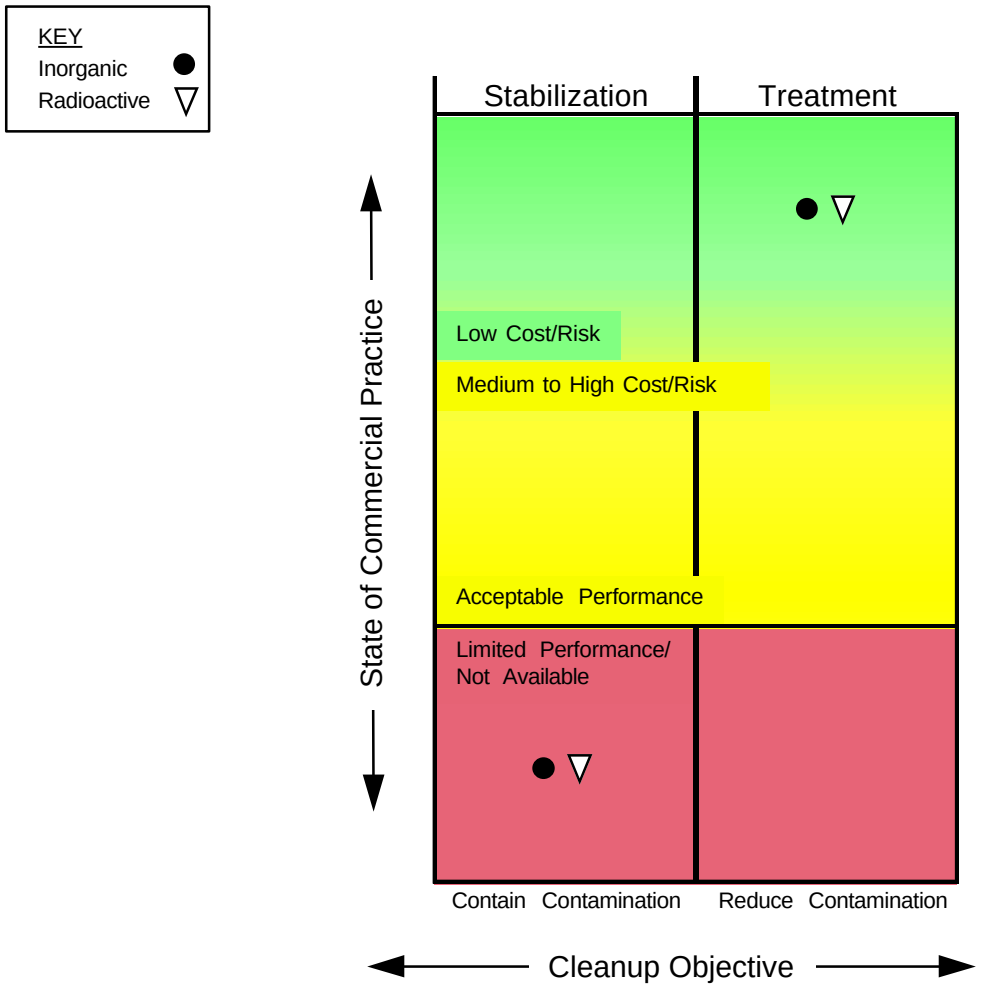
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1 FT. AND COMBUSTIBLES



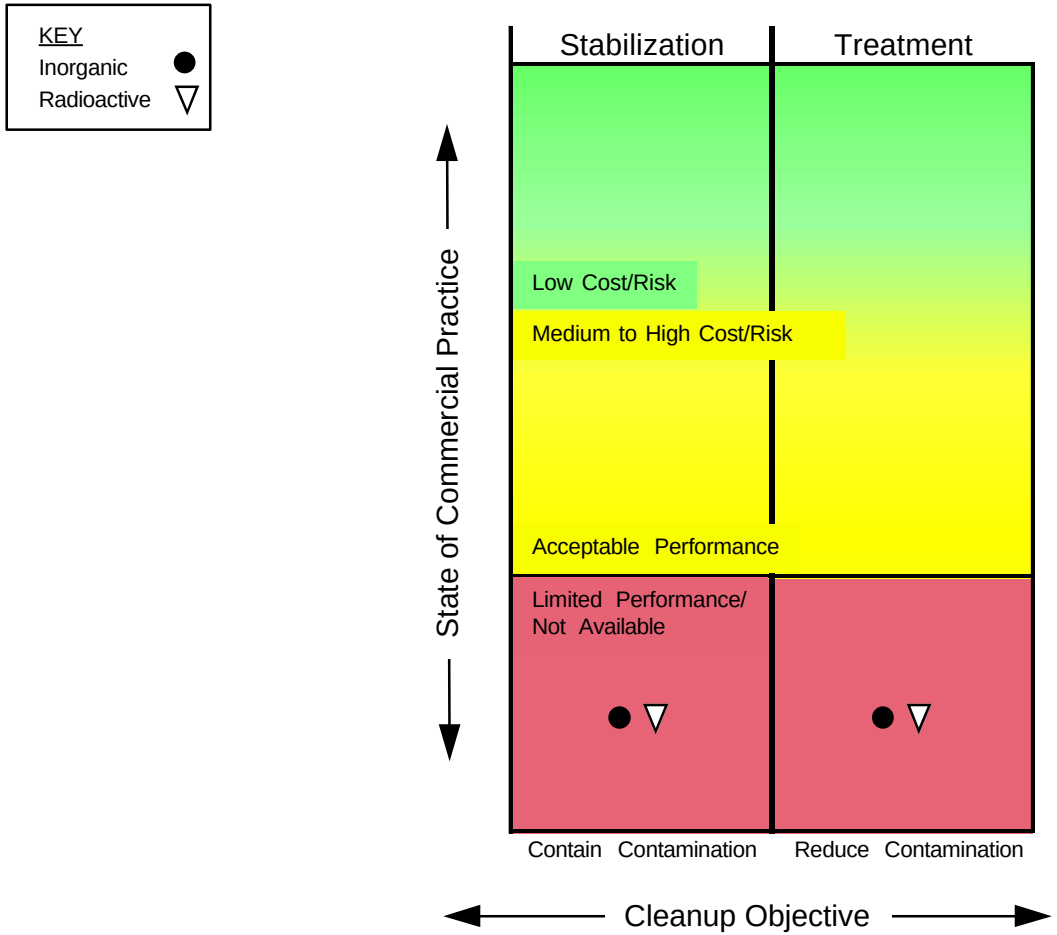
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1 FT. AND LEAD BRICKS



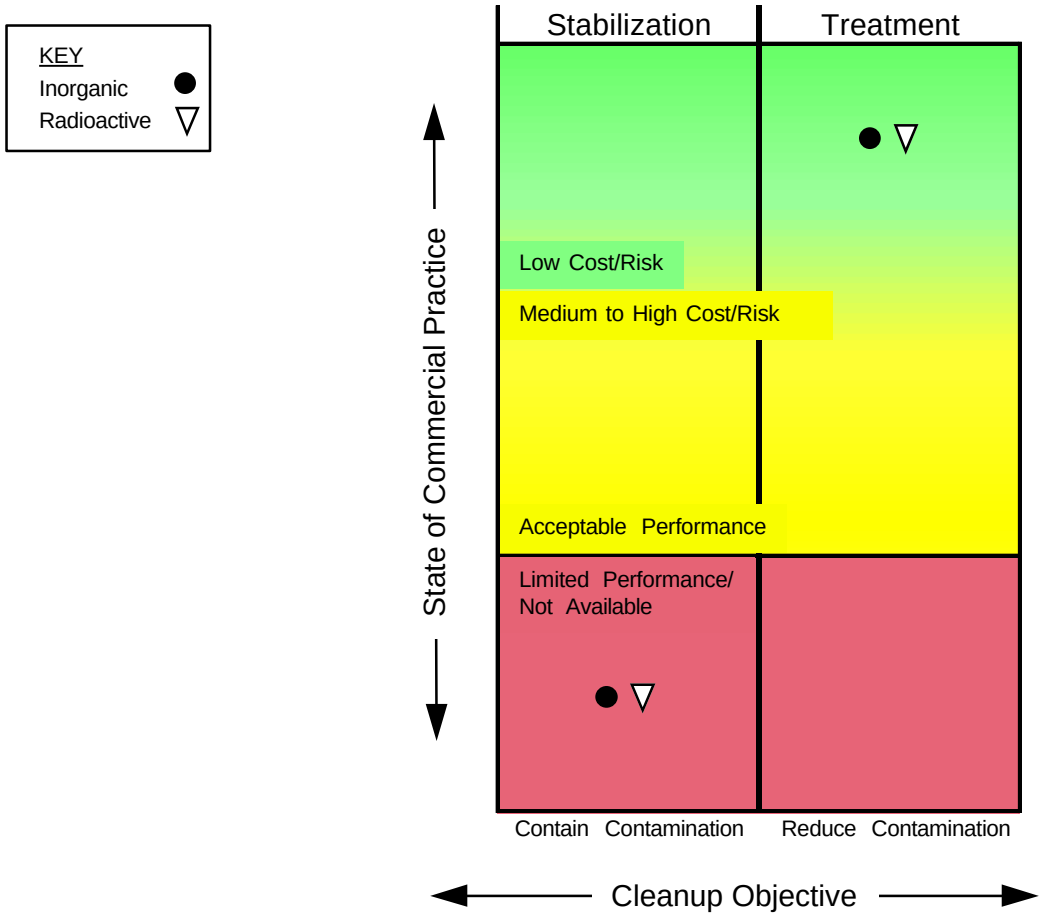
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1 FT. AND DISCERNABLE ENERGETICS



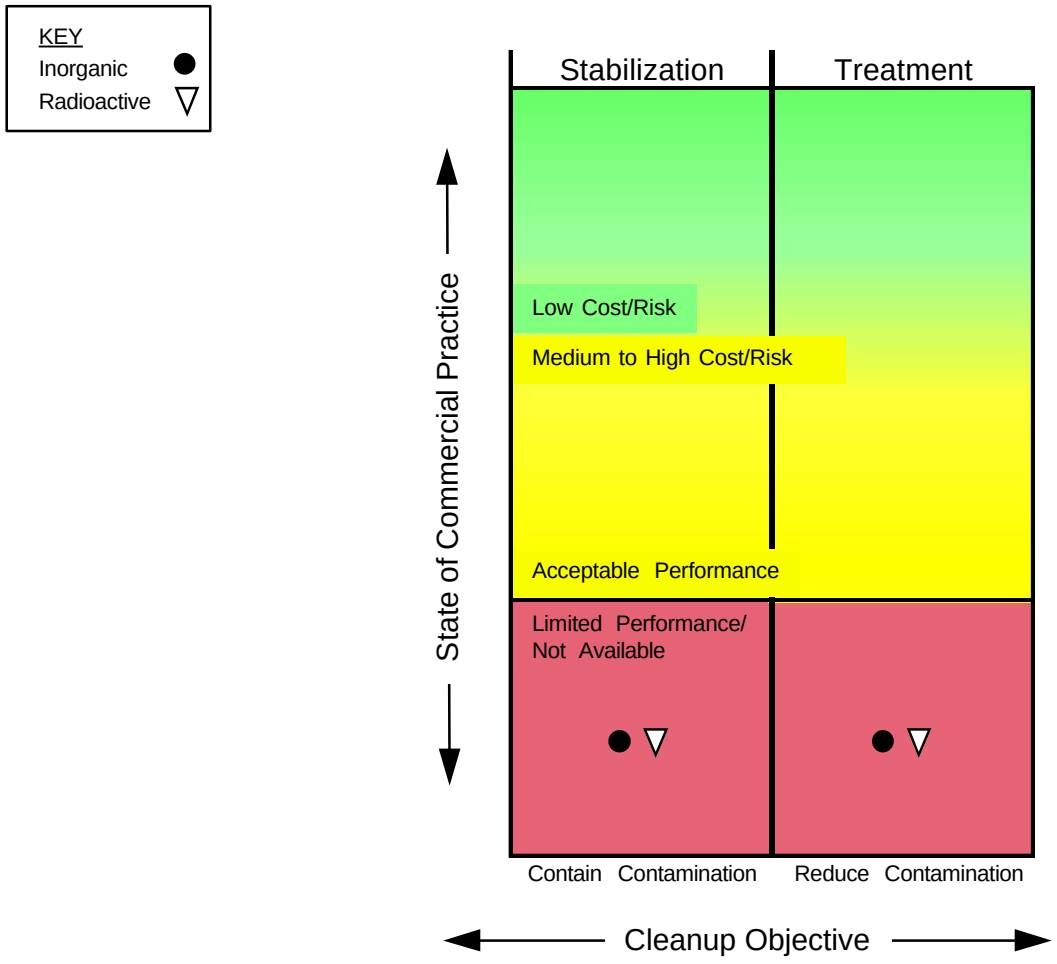
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH COMBUSTIBLES AND LEAD BRICKS



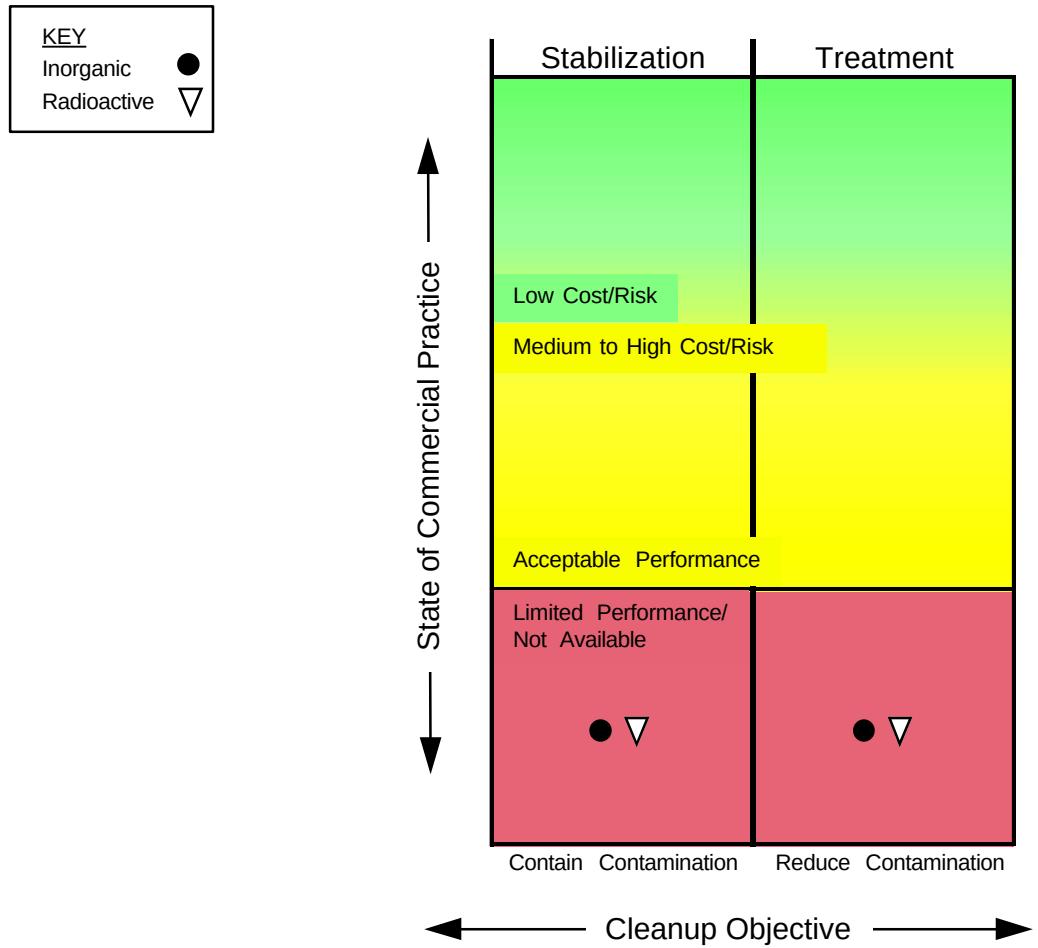
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH COMBUSTIBLES AND DISCERNABLE ENERGETICS



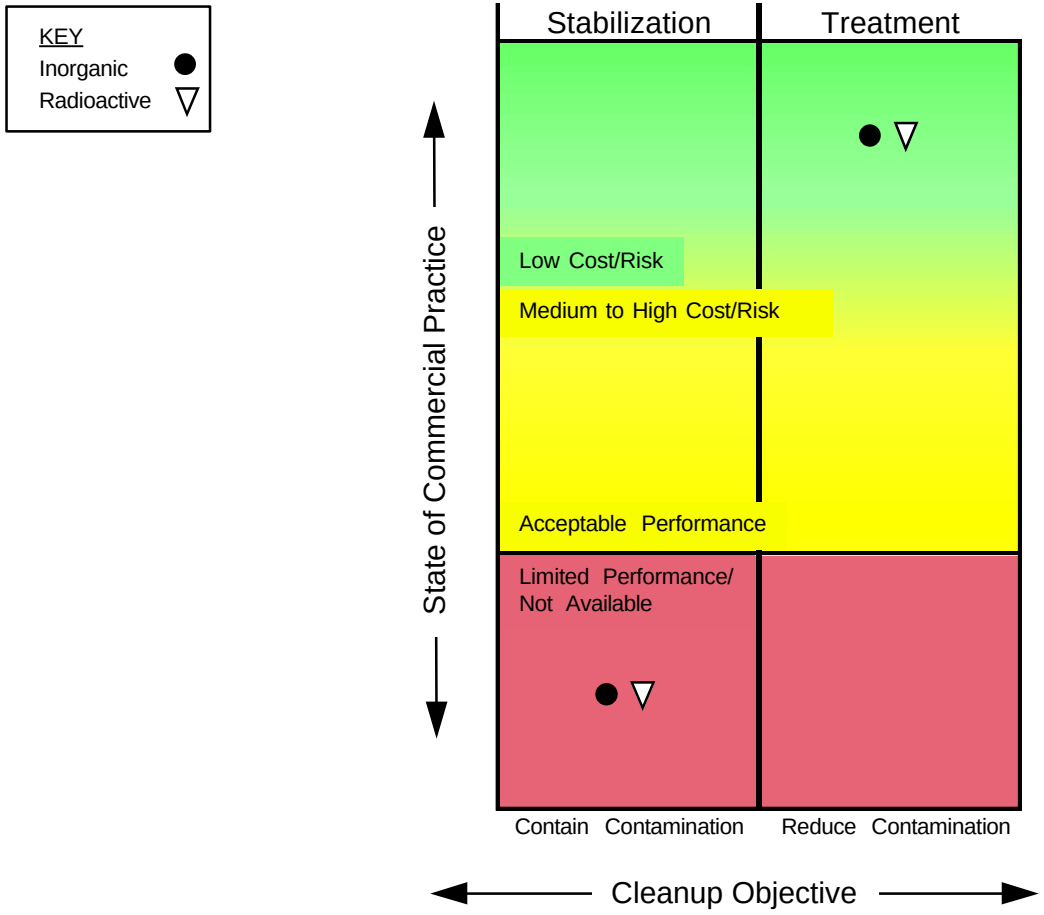
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH LEAD BRICKS AND DISCERNABLE ENERGETICS



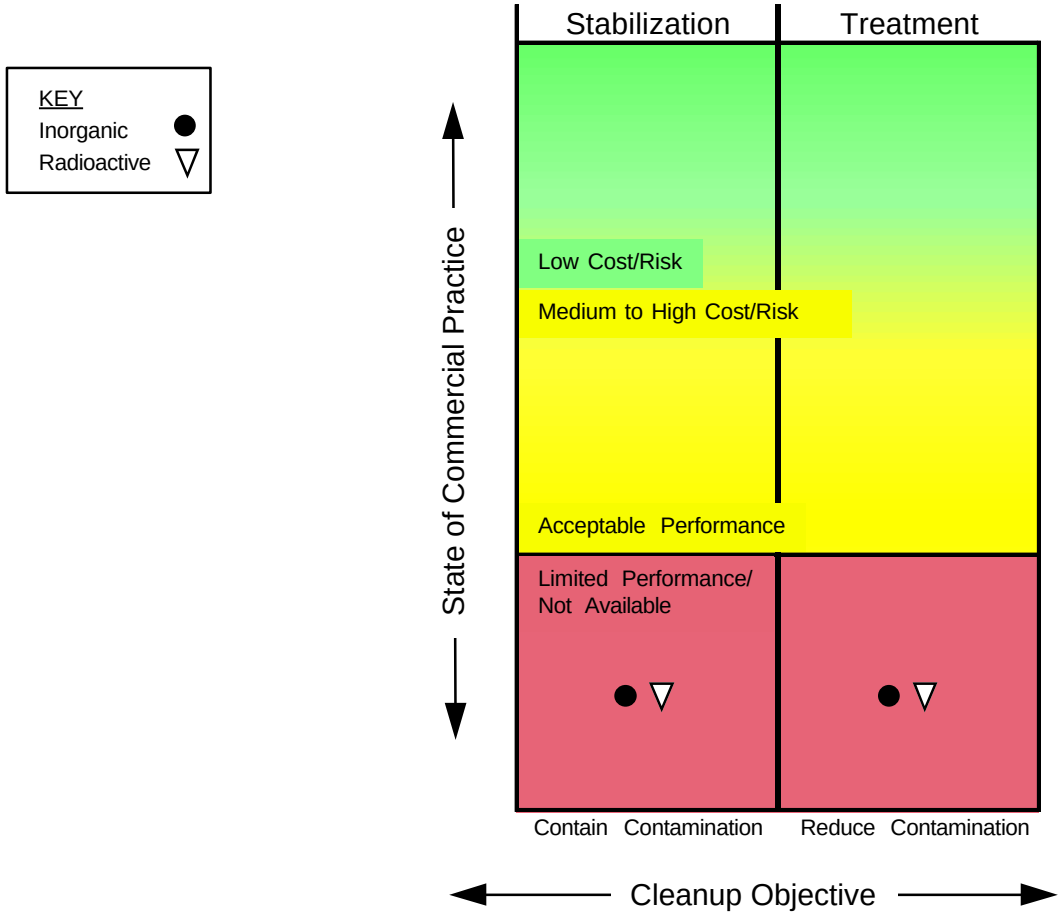
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1FT., COMBUSTIBLES, AND LEAD BRICKS



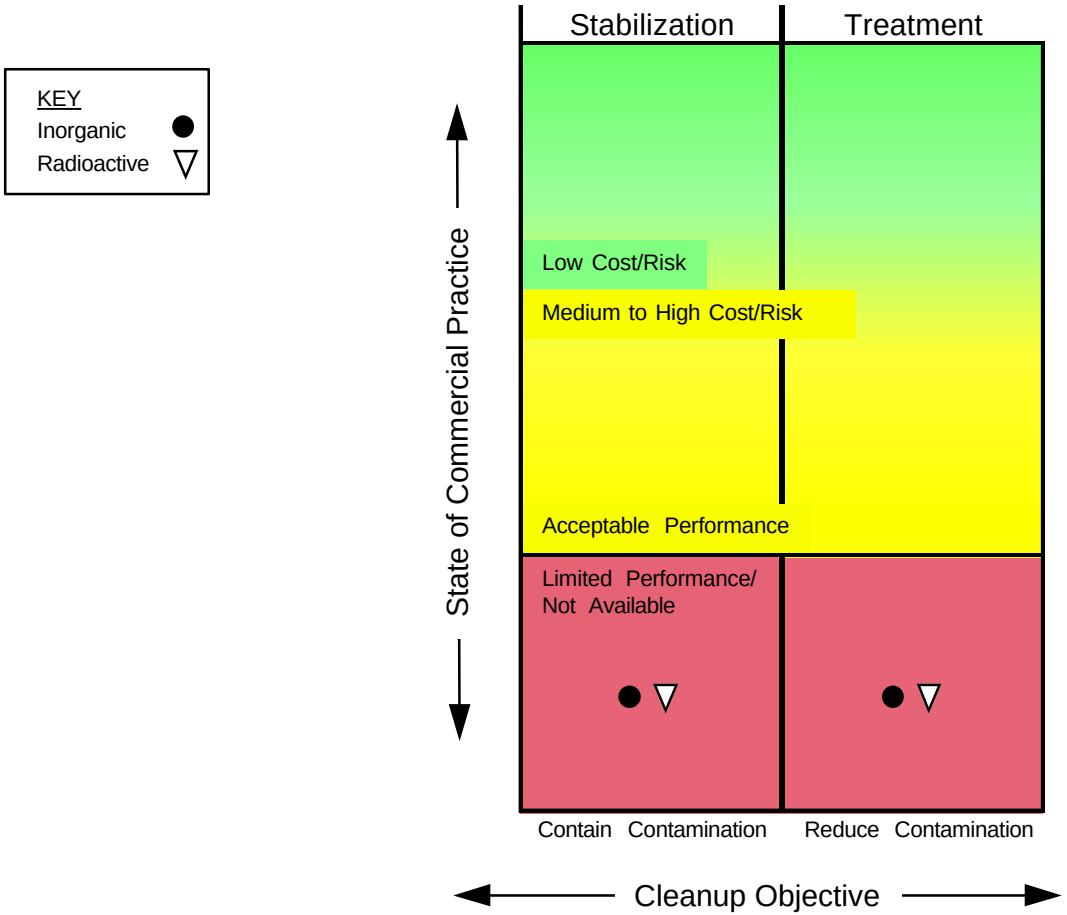
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1FT., COMBUSTIBLES, AND DISCERNABLE ENERGETICS



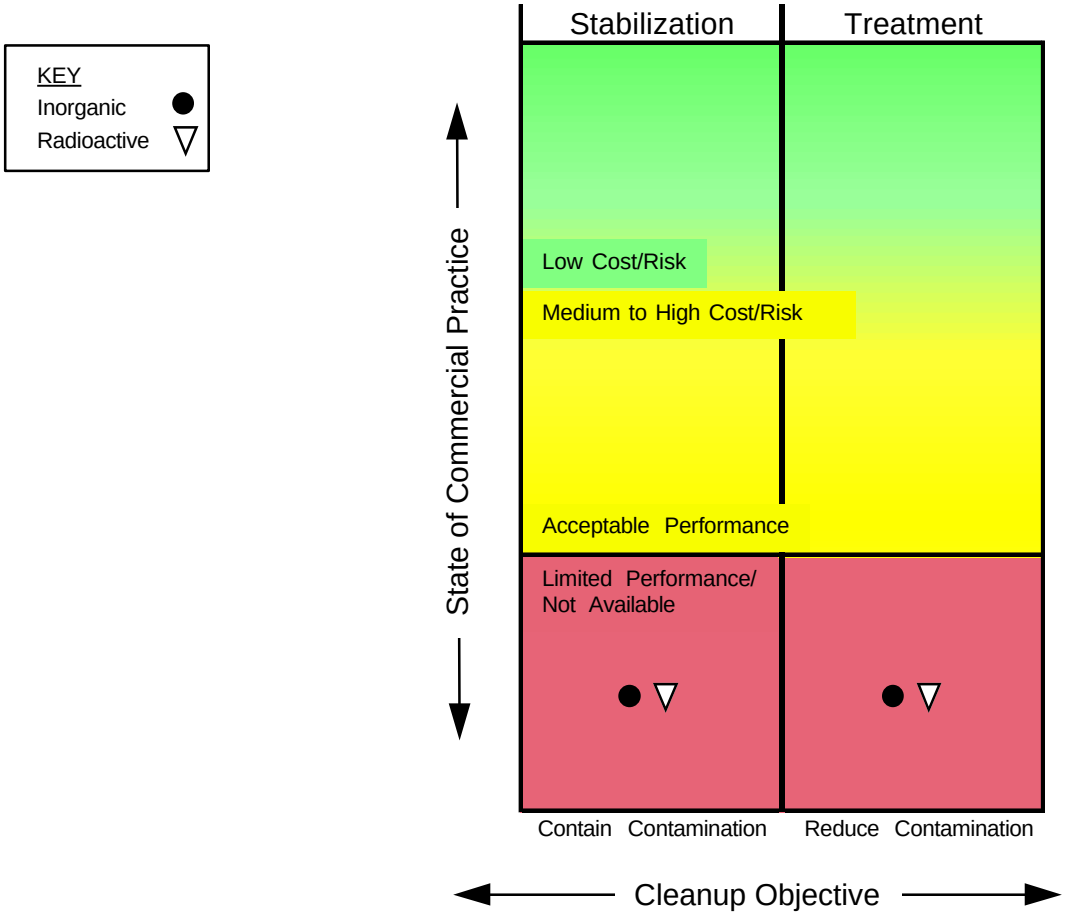
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH SIZE >1FT., LEAD BRICKS, AND DISCERNABLE ENERGETICS



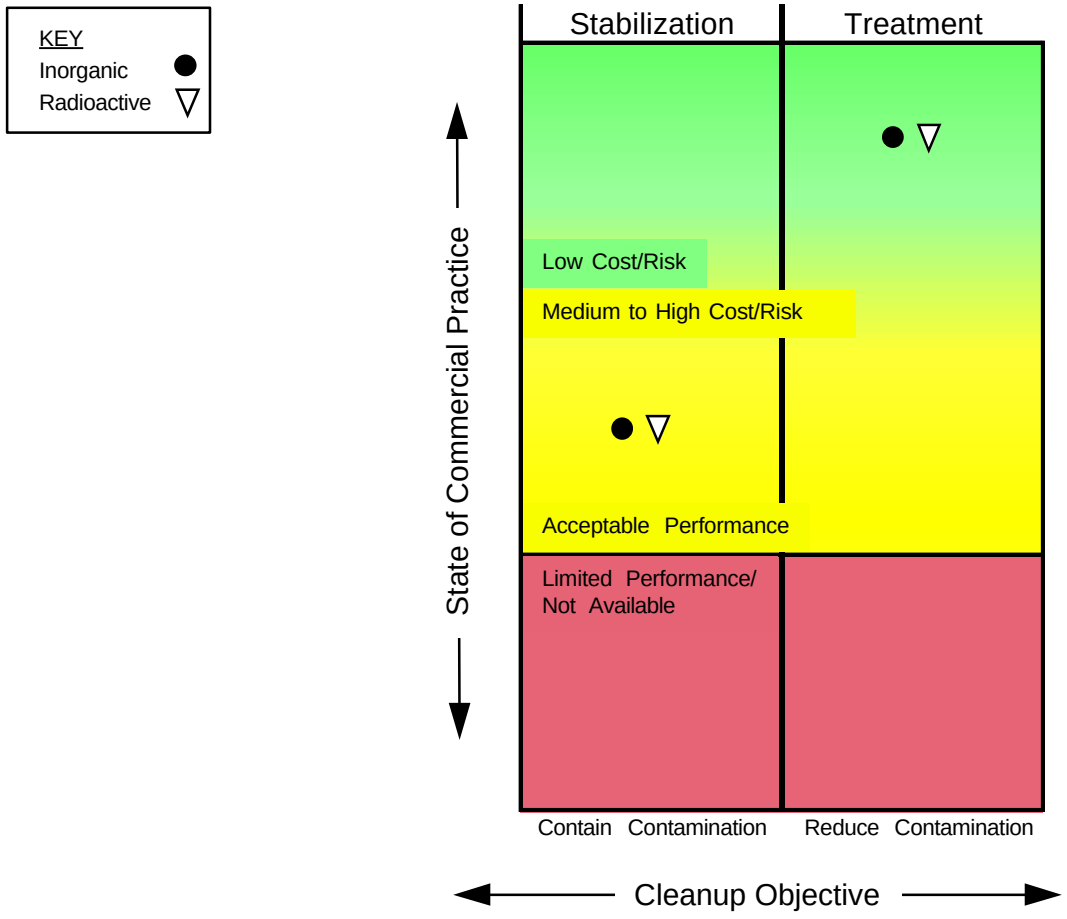
Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS WITH COMBUSTIBLES, LEAD BRICKS, AND DISCERNABLE ENERGETICS



Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

ASBESTOS IN ALL OTHER CONDITIONS



Note: Refers to Tables 54 and 60 of the Remediation/Waste Processing PAM

STABILIZATION AND TREATMENT OF ASBESTOS-INORGANIC AND RADIOACTIVE

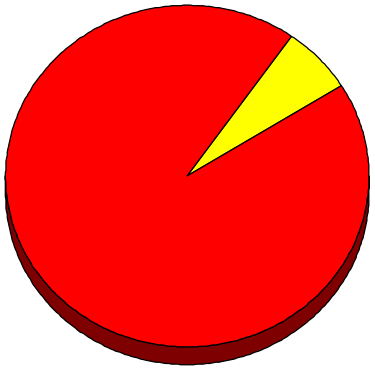
- Stabilization technologies cannot resolve this problem set if size is greater than 1ft. or combustibles, lead bricks, or discernable energetics are present, because for many conditions, there is only one technology available or none at all.

- Treatment provides good-performance, low-cost/risk alternatives in all conditions without discernable energetics present.

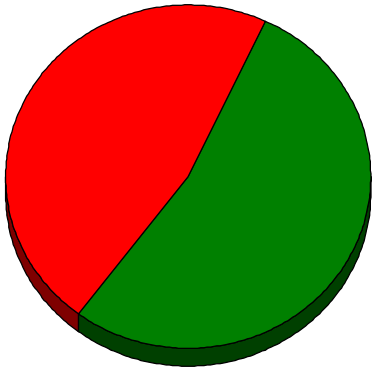
- As stated in the assumptions, it is assumed that alternatives are readily available for disposal.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE ASBESTOS PROBLEM SETS[1,2]

Stabilization



Treatment



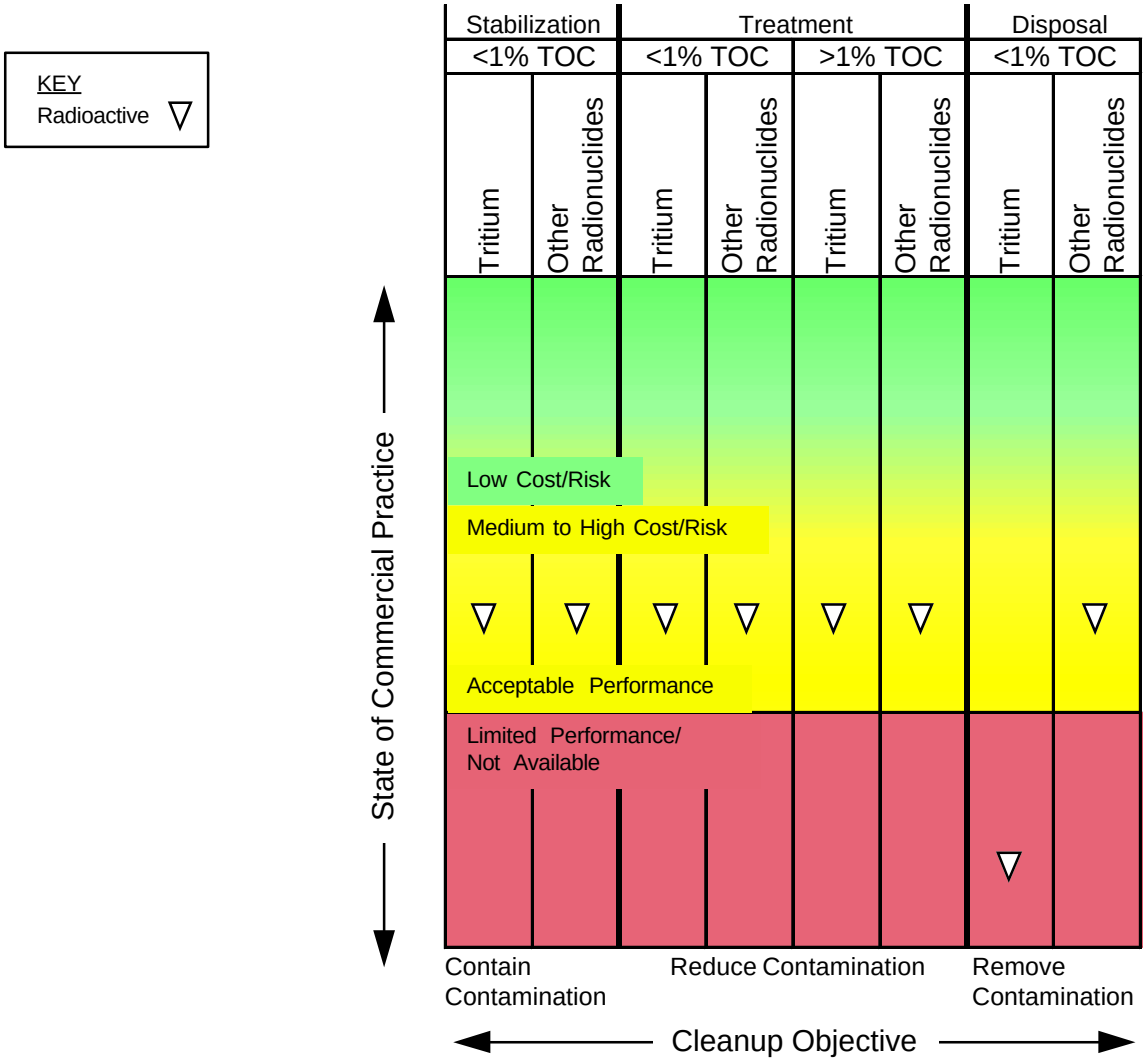
- Treatment offers promising alternatives for over half of the conditions considered, and stabilization provides almost no prospects.
- Likewise, treatment has the best prospects for performance-based contracting.

Opportunities for performance- based contracting		Commercial state of practice satisfies the problem sets in the conditions considered
		Commercial state of practice needs improvement for the problem sets in conditions considered
No performance-based contracting opportunities		Commercial state of practice cannot satisfy the problem sets in the conditions considered

[1] Pie charts represent percentage of conditions in the PAM in asbestos problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

[2] Low-cost/risk alternatives are assumed to be available

SLUDGE - RADIOACTIVE



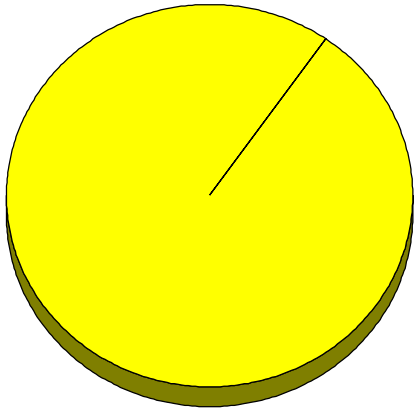
Note: Refers to Table 35 of the Remediation/Waste Processing PAM

STABILIZATION, TREATMENT, AND DISPOSAL OF SLUDGE/RESIDUES - RADIOACTIVE

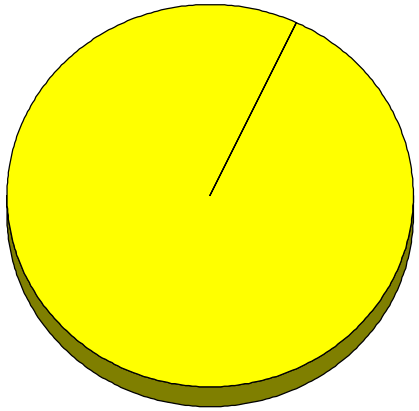
- Stabilization needs improvements to meet the requirement as inorganic encapsulation is the only good performance, low cost/risk alternative.
- Treatment needs improvement for all conditions considered, because many of the alternatives are rated no better than potential due to performance, cost, and risk considerations.
- Disposal needs improvement for radionuclides in conditions without tritium due to the high cost; where tritium is present, disposal is absent due to regulatory considerations.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE SLUDGE PROBLEM SET[1]

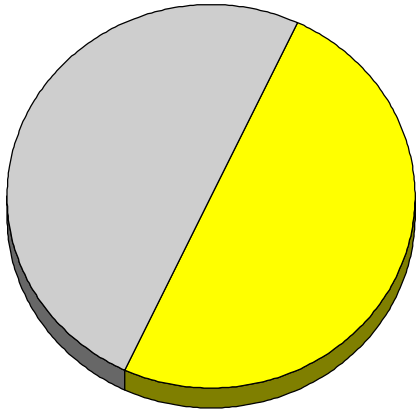
Stabilization



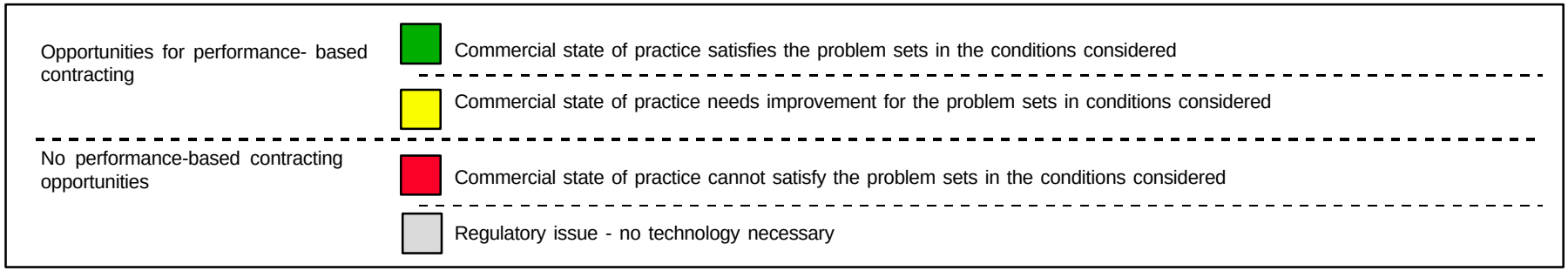
Treatment



Disposal

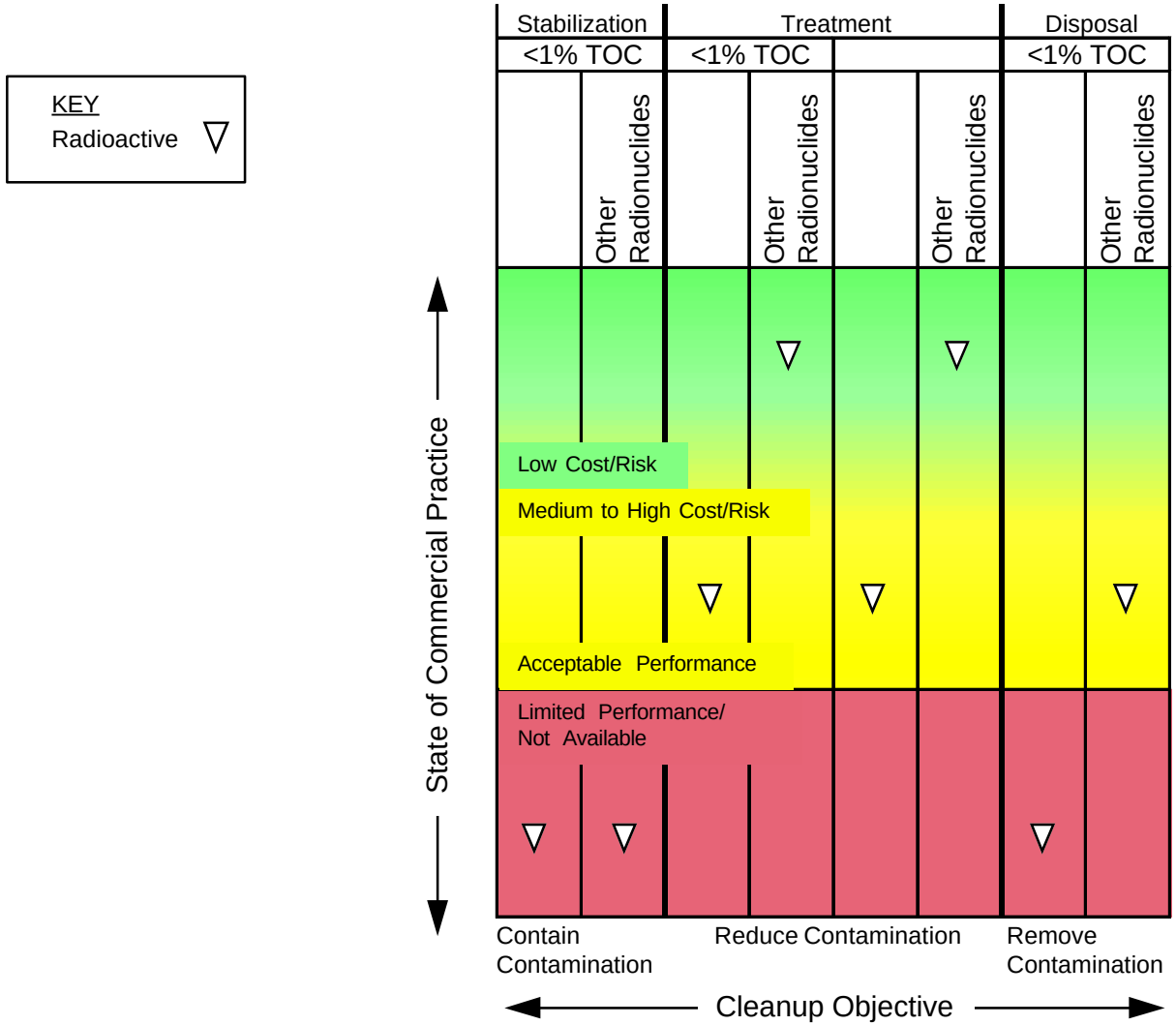


- Stabilization, treatment, and disposal are areas needing significant improvement for sludge.
- All conditions considered for treatment and stabilization offer performance-based contracting opportunities, but there are fewer opportunities for disposal.



[1] Pie charts represent percentage of conditions in the PAM in sludge problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary.

LIQUIDS- RADIOACTIVE



Note: Refers to Table 43 of the Remediation/Waste Processing PAM

STABILIZATION, TREATMENT, AND DISPOSAL OF LIQUIDS - RADIOACTIVE

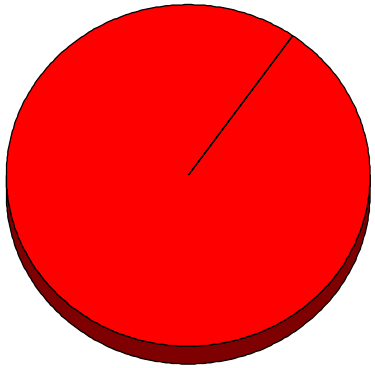
- Stabilization cannot resolve this problem set, because for the two conditions considered, there is no technology or only one technology available.

- Treatment needs improvement in conditions with tritium, and fully satisfies liquids with other radionuclides due to precipitation/filtration and solar evaporation.

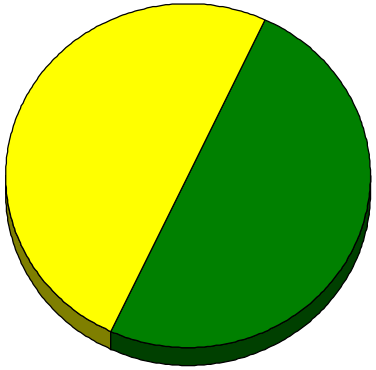
- Disposal needs improvement for radionuclides in conditions without tritium due to the high cost; where tritium is present, disposal is absent due to regulatory considerations.

SUMMARY OF THE TECHNOLOGY SCREENING ANALYSIS FOR THE LIQUIDS PROBLEM SET[1]

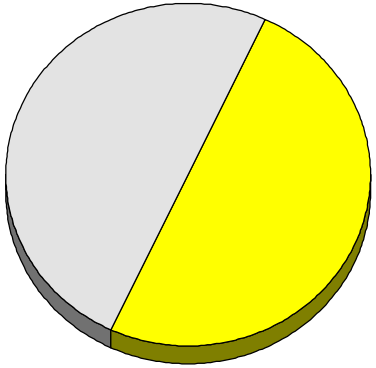
Stabilization



Treatment

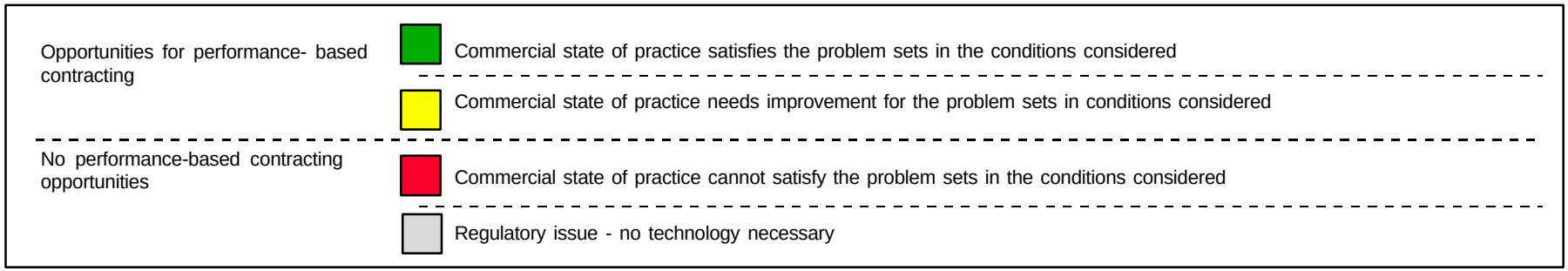


Disposal



- Treatment offers the most alternatives for liquids problem sets as stabilization and disposal offer little to no prospects.

- Likewise, treatment has more opportunities for performance-based contracting than the other two strategies.



[1] Pie charts represent percentage of conditions in the PAM in liquids problem sets can be satisfied, marginally satisfied, or not satisfied; regulatory issues exist; or no technology is necessary

CORE DATABASE RESPONSE STRATEGIES AT THE CORE REPORTING LEVEL PROVIDE A BASIS OF COMPARISON WITH THE PAM RESULTS

- Disposal and transfer to EM-30 are the most frequently reported response strategies across the media; the media totals below are dominated by radioactively contaminated solids/debris (including metals) for which there are acceptable-performance, medium-cost/risk alternatives and sanitary solids/debris for which there are assumed to be low-cost/risk alternatives.

- Treatment has the next highest incidence which is consistent with the availability of low to medium-cost and risk treatment alternatives, as identified by the PAMs.

	Number of CRLs by Medium						
Response Strategy	**Solids/ Debris**	**Metals**	**Asbestos**	**Concrete/ Masonry/ Brick**	**Wood Products**	**Sludge**	**Liquid**
Access/Inst. Control	**10**	**3**	**3**	**2**	**2**	**0**	**0**
Collect and Dispose	**292**	**285**	**74**	**40**	**28**	**8**	**25**
Collect and Recycle	**5**	**5**	**5**	**4**	**4**	**0**	**0**
Collect and Store	**6**	**6**	**1**	**0**	**0**	**0**	**2**
Collect and Treatment	**33**	**40**	**12**	**0**	**0**	**0**	**3**
In-Situ Containment	**2**	**0**	**0**	**0**	**0**	**0**	**0**
In-Situ Treatment	**2**	**1**	**0**	**0**	**0**	**0**	**0**
New (Further) Trmt	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Transfer to EM-30	**464**	**30**	**160**	**7**	**0**	**0**	**5**
No Action	**0**	**0**	**0**	**0**	**0**	**0**	**0**

THIS ANALYSIS ADVANCES DOE's CONTINUING ASSESSMENT OF REMEDIATION TECHNOLOGY NEEDS

- The 1991 Technology Needs Assessment (TNA I) advocated better data and improved communication about technology needs and technology development

- The 1993 Technology Needs Crosswalk Report (TNA II) identified areas for improvement that are largely being met now by:

  - Technology Task Plan improvements in quality and consistency

  - Focus Area initiatives and composition

  - Use of the EM-40 Core Database

- The present analysis moves remediation technology development forward by:

  - Identifying priority problems sets

  - Identifying technology gaps and areas for improvement by the marketplace

- Identifies opportunities for performance-based contracting by problem type
- The next step is to link priority needs with their necessary timing.

THE END GOAL: THE RIGHT TECHNOLOGY AT THE RIGHT TIME AT THE RIGHT SITE

DIRECT FOLLOW-ON ACTIVITIES AND RELATED EFFORTS POINT TO THE NEXT STEPS

- Communicate results:
  - Articulate/substantiate EM-40 program requirements
  - Communicate competitive contracting opportunities.

- Conduct further analysis:
  - Develop priority basis for requirements
  - Compare preferred alternatives to Environmental Restoration program experience
  - Develop program strategy.

- Update PAMs as necessary to reflect incoming cost and performance data, contracting experience, and newly available technologies.

- Enhance data:
  - Enhance Core Database to support program analysis
  - Assure input data quality
  - Resolve cost data issues.

THE SHORT ANSWER

INTRODUCTION

PROBLEM SET DEFINITION

TECHNOLOGY SCREENING ANALYSIS

NEXT STEPS

RESULTS OF THE ENVIRONMENTAL RESTORATION DECOMMISSIONING TECHNOLOGY REQUIREMENTS DEFINITION WILL BE COMMUNICATED TO PROSPECTIVE USERS OF THE INFORMATION AND TO DECISION-MAKERS

- Decommissioning requirements definition results are being presented to senior managers as well as program managers and staff in EM-40 and EM-50, to the Technology Focus Area leads, and to representatives of the Site Technology Coordination Groups.

- This analysis, which articulates and substantiates EM-40 decommissioning problem sets and technology requirements, will be made available within and across EM-40 and to the larger EM organization, to encourage technology development and transfer decisions and technology selection decisions consistent with these requirements.

FURTHER ANALYSES ARE NEEDED TO ASSESS TECHNOLOGY SCREENING RESULTS IN LIGHT OF CURRENT PROGRAM PRACTICE AND PRIORITIES

- A more detailed comparison of preferred alternatives with actual Environmental Management experience is needed to:
  - Identify influences in technology selection other than performance, cost, or risk.
  - Confirm the superiority of technologies identified as preferred, or make adjustments to PAM rankings as necessary.

- These Requirements Definition findings need to be compared to planned schedules for addressing problem sets to ensure that the right technology is available at the right time and to establish priorities accordingly. Such an analysis cannot be conducted complex-wide at this time because:
  - No centrally-available information source contains decision milestones that can be directly linked to problem sets at every site in the complex.
  - Information that is available at HQ is defined and reported by each site as appropriate to its own needs and thus is not consistent; as a result, the information cannot be aggregated or analyzed from a national program perspective.

DATA ENHANCEMENTS ARE NEEDED TO STRENGTHEN THESE REQUIREMENTS DEFINITIONS AS DECISION TOOLS

- Further Environmental Restoration program technology requirements definitions would benefit from adjustments to the Core Database structure to link certain data elements more directly and to promote program-wide contrasts and comparisons (e.g., more direct link between problem set and response strategy).

- Continuing input data quality reviews and follow-up action as necessary would increase both the validity and the utility of the Core Database contents (e.g., contaminant data values, contaminated media data values).

- Cost and decision milestone data need to be directly correlated to problem sets to support identification of priority problem sets.

THE ENVIRONMENTAL RESTORATION REQUIREMENTS DEFINITION WILL CONTINUE TO EVOLVE

- The overall Environmental Restoration Requirements Definition will be updated each year in advance of the Internal Review Budget to support planning and budgeting.

- Preferred Alternatives Matrices for remediation/waste processing, decommissioning, and characterization/monitoring will be issued in final form in June 1997 and will include technology profiles and assumptions and limitations.

- Annual updates to the PAMs will issued each spring.

- These publications will be posted on the World Wide Web, on DOE's Environmental Management Home Page at http\\em.doe.gov\define as they become available.